U.S. Army Public Health Command
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EPIDEMIOLOGICAL REPORT NO. 12-HF-97HRF1A-10

PROSPECTIVE INVESTIGATION OF INJURY RATES AND INJURY RISK FACTORS AMONG FEDERAL BUREAU OF INVESTIGATION NEW AGENT TRAINEES, QUANTICO VIRGINIA, 2009-2010

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14. ABSTRACT A one-year prospective examination was conducted of injury rates and injury risk factors during Federal Bureau of Investigation (FBI) new agent training. Injuries were obtained from medical records at the FBI academy and injury compensation forms. Potential injury risk factors were obtained from a lifestyle questionnaire and existing data at the FBI Academy. A total of 426 men and 105 women were involved in the project. Thirty-five percent of men and 42% of women had one or more injuries during training. The most common diagnoses were traumatic sprains (14%), traumatic strains (12%), musculoskeletal pain (12%), abrasions/lacerations (11%), and contusions (11%). The most common anatomical locations were the knee (10%), thigh (8%), shoulder (8%), eye (8%), finger (7%), face (6%), lower back (6%), and head (5%). The most common activities associated with injuries were defensive tactics (58%), physical fitness training (20%), physical fitness testing (5%), and firearms training (3%). Among the men, higher injury risk was associated with older age, slower 300-meter sprint speed, slower 1.5-mile run time, lower total points on the PFT, lower self-rated fitness, lower or higher frequency or duration of aerobic exercise, a prior upper or lower limb injury, and current foot or knee pain. Among women, higher injury risk was associated with slower 300-meter sprint speed, slower 1.5-mile run time, lower total points on the PFT, current back pain, and other factors. Initial fitness test scores of at least 12 points for men and 15 points for women were associated with the lowest injury risk in training. Recommendations for reducing injury risk include: 1) encouraging trainees to arrive at the FBI Academy with an entry level PFT score of 12 for men and 15 for women, 2) encouraging aerobic exercise 3-4 times/week, 20-30 minutes/session prior to new agent training, 3) emphasizing the association between low fitness and higher injury risk to new agent trainees and to FBI field offices, 4) continuing statistical analysis of PFT failure rates and providing these reports to field offices, 5) examining defensive tactics training to determine whether injury risk can be further reduced, 6) improving information collection on injury mechanisms by obtaining both the activity associated with the injury and the mechanism of injury, 7) using the most common injuries identified here to assist in medical planning, 8) remaining vigilant for symptoms of exertional rhabdomyolysis, and 9) continuing to investigate associations between prior injury and pain that limits activity to determine whether prophylactic measures can be put in place to further reduce injury risk in training.

15. SUBJECT TERMS: Defensive tactics, physical activity, physical fitness, physical training, menstrual history, smoking, demographics, push-ups, sit-ups, 300-meter run, 1.5-mile run, age, height, weight, body mass index, prior injury, pain, activity limitations

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EXECUTIVE SUMMARY
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1. INTRODUCTION AND PURPOSE. The Federal Bureau of Investigation (FBI) Human Resources Division, Office of Medical Services, Health Care Programs Unit, requested the assistance of the United States Army Public Health Command (USAPHC) in injury prevention efforts at the FBI New Agent Training Program at the FBI Academy, Quantico, Virginia. An Interagency Agreement was completed for a two phase project. Phase 1 was a retrospective examination of available records to describe injury rates and physical fitness among new agent trainees and to examine relationships between fitness and injuries. Phase 2 was a more comprehensive prospective examination of injuries and injury risk factors but with fewer new agents involved. This report details the results of Phase 2.

2. METHODS.

a. This project employed a prospective cohort design. New agents enrolled in the project were those arriving for the 21-week FBI New Agent Training Courses conducted between March 2009 and March 2010. Shortly after arrival for the course, the men and women completed a lifestyle questionnaire that asked about age, height, weight, tobacco use, physical activity, self-assessed physical fitness, prior injuries and (for women) menstrual history. They also completed a New Agent Trainee Profile that asked them about educational level, marital status, number of children, foreign languages spoken, military experience, law enforcement experience, and dominate hand. Standard Form 88 (SF88, Report of Medical Examination) was used to obtain information on the new agent's gender, height, weight, race, and date of birth.

b. Physical fitness test (PFT) data were obtained from a database in the Physical Fitness Training Section of the FBI Academy. The PFT consisted of four scored events: push-ups to exhaustion, 1-minute sit-ups, a 300-meter run, and a 1.5-mile run. Points were assigned to performance levels on each PFT event; passing the test required a score of 12 with at least 1 point on each event.

c. Injury data were obtained from the Medical Data Base (MDB), where medical care providers at the FBI Academy Health Clinic at Quantico, Virginia, routinely entered information on medical encounters. USAPHC personnel examined each of the new agent's medical encounters and determined if the encounter was for an injury or for other medical care. For each injury encounter, extracted information included the date of visit, type of visit (new injury visit or follow-up on a previous visit), diagnosis, anatomical location, and activity associated with the

injury. Injury information was also obtained from the United States Department of Labor's, CA-1 form (Federal Employee's Notice of Traumatic Injury and Claim for Continuation of Pay/Compensation). The CA-1 was used to enhance information regarding the activity associated with the injury and in some cases the injury diagnosis and anatomical location. An injury case was defined as a new agent who sustained physical damage to the body and sought medical care or medical compensation one or more times during the period of new agent training.

3. RESULTS.

a. A total of 426 men and 105 women were involved in this prospective project. There were 315 new injury cases and 44 follow-up encounters. Thirty-five percent of men and 42% of women had one or more injuries (relative risk (women/men)=1.20, 95%confidence interval (CI)=0.93-1.55). The injury incidence rates were 2.54 and 3.22 per 1,000 person-days among the men and women, respectively (rate ratio (women/men)=1.26, 95% CI=0.90-1.77). Overuse and traumatic injury cases made up 14% and 68% of new injury cases, respectively. The most common diagnoses were traumatic sprains (14%), traumatic strains (12%), musculoskeletal pain (12%), abrasions/lacerations (11%), contusions (11%), and insect bites (11%). The most common anatomical locations were the knee (10%), thigh (8%), shoulder (8%), eye (8%), finger (7%), face (6%) lower back (6%), and head (5%). The most common activities associated with injuries were defensive tactics (58%), physical fitness training (20%), physical fitness testing (5%) and firearms training (3%).

b. Among the men, higher injury risk was associated with: older age, slower 300-meter sprint time, slower 1.5-mile run time, fewer total points on the PFT, lower self-rated fitness, lower or higher frequency or duration of aerobic exercise, a prior upper or lower limb injury (especially if the injury was still limiting activity), and foot or knee pain limiting activity. Among the women higher injury risk was associated with: slower 300-meter sprint time, slower 1.5-mile run time, fewer total points on the PFT, back pain limiting activity, and other factors. Initial PFT scores of 12 points or higher for men and 15 points or higher for women were associated with the lowest injury risk in training.

c. A majority of the new agents reported to the Academy with favorable lifestyle characteristics. Only 3% of men and women had smoked a cigarette in the last two months; 6% of men and 1% of women had used smokeless tobacco in the same period. Ninety-five percent of men and 96% of women performed vigorous aerobic activity at least 3 days/week for at least 16-30 minutes/session in the previous two months; 77% of men and women had performed weight training at least twice a week in the last 2 months. These activity levels are those recommended by the American College of Sports Medicine for improving aerobic and muscle strength fitness. High levels of aerobic training (≥5 days/week) were associated with higher injury risk.

4. RECOMMENDATIONS:

a. Encourage new agents to arrive at the FBI Academy in physical condition to achieve an entry level PFT score of at least 12 for men and 15 for women. Lower scores were associated with higher injury risk. A higher level of aerobic fitness (faster 1.5-mile run times) appears to be of particular importance.

b. Encourage a moderate amount of aerobic exercise prior to new agent training. Prospective data suggested that too much or too little aerobic activity was associated with higher injury risk. Recommended frequency is 3-4 times/week for 20-30 minutes each time. Encourage strength training twice a week.

c. Emphasize the association between low fitness and higher injury risk to new agent trainees and to FBI field offices by providing quantitative information from both retrospective and prospective investigations.

d. Continue statistical analysis of PFT failure rates and provide these reports to field offices to motivate them to more adequately prepare new agents in terms of their physical fitness.

e. Examine defensive tactics training to determine if injury risk can be reduced. By far, the largest numbers of injuries were associated with defensive tactics training in both the retrospective and prospective investigations. Many safety measures are already in place and the training staff is knowledgeable and alert to safety concerns. Nonetheless, defensive tactics should be further reviewed to determine whether additional safety measures can be implemented.

f. Improve reporting of information on injury mechanisms by obtaining information on both the activity associated with the injury and the mechanism of injury.

g. Use the most common injuries identified in the retrospective and prospective investigations to assist in medical planning. These injuries included strains, sprains, contusions, and abrasions/lacerations.

h. Remain vigilant for symptoms of exertional rhabdomyolysis (ER). Although ER is an infrequent diagnosis, the Physical Training Unit, as well as medical providers, should remain knowledgeable about this problem and aware of the symptoms. New agents with persistent symptoms or symptoms that exceed those of delayed onset muscle soreness should be escorted to the medical clinic so their symptoms can be properly diagnosed.

i. Continue investigating associations between prior injury and pain that limits activity to determine whether prophylactic measures can be put in place to reduce injury risk in training.

CONTENTS

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1. REFERENCES. Appendix A contains the scientific/technical references used in this report.

2. INTRODUCTION AND PURPOSE.

a. In April 2008, The Federal Bureau of Investigation (FBI) Human Resources Division, Office of Medical Services, Health Care Programs Unit (HCPU), requested the assistance of the United States Army Center for Health Promotion and Preventive Medicine (USACHPPM), now the US Army Public Health Command, Provisional (USAPHC). The HCPU asked USAPHC personnel to apply their experience in injury prevention programs in military training to assist in injury prevention efforts in the FBI New Agent Training Program at the FBI Academy, Quantico, Virginia (VA). On 24 April 2008, USAPHC representatives traveled to FBI Headquarters for initial discussions. HCPU informed USAPHC of a number of recent cases of rhabdomyolysis, but the discussions were broader, involving injuries of all types at the FBI Academy. On 19 May 2008, a subsequent meeting was held at the FBI Academy at Quantico, VA, hosted by the FBI's Assistant Director of the Training Division. On this date, USAPHC briefed the training division, medical staff, and FBI Headquarters managers on similar program evaluations and injury prevention recommendations USAPHC had made Army-wide. USAPHC personnel proposed a methodology to evaluate injury incidence and injury risk factors among FBI new agent trainees. FBI personnel provided USAPHC personnel with a tour of the FBI Academy medical and training areas to further determine the feasibility of the project.

b. USAPHC and FBI representatives concluded that the project was feasible and two projects were proposed. One project would be a retrospective examination of available records to describe new agent injury rates and physical fitness, and to examine relationships between physical fitness and injuries. The project would be carried out with medical data (available back to 1999) in a medical database and physical fitness test data (available back to 2002) in another computer database. A second, more detailed prospective project would involve fewer new agent trainees and would progressively enroll new agent trainees as they entered the FBI Academy. An Interagency Agreement (Appendix B) was completed on 5 February 2009. On 25 February 2009, USAPHC met with the medical staff and training division to make final arrangements for data collection. The project began in March 2009.

c. This report details the results of the prospective portion of the project. The purpose of this report is to examine the following in FBI new agent training: 1) injuries and injury rates from March 2009 to March 2010, and 2) factors associated with these injuries. A previous report covered the retrospective (historic) portion of the project.[1] For simplicity, new agent trainees are referred to as simply "new agents" throughout this report.

3. AUTHORITY.

a. Under Army Regulation 40-5,[2] the USACHPPM is responsible for providing epidemiological consultation services upon request. This project was initiated by a request from the FBI Human Resources Division, Office of Medical Services, and HCPU. The HCPU lacked epidemiological support and under Title 31, United States Code, Section 1535, Economy Act, it was considered appropriate to request the assistance of the PHC to study injuries and injury risk factors in new agent training. An interagency agreement was developed and signed by the appropriate parties (Appendix B).

b. Employing the criteria of the Council of the State and Territorial Epidemiologists,[3] PHC determined that this project constituted public health practice. This decision was reviewed by the Human Use Committee of the FBI who concurred with the determination.

4. BACKGROUND. This background section covers injuries and physical fitness, as well as associations between injuries and fitness, physical activity, and cigarette smoking. Each section begins with available literature on law enforcement, and then covers military and civilian groups where literature is available on these groups. The final section covers information on the definition, prevalence, risk factors, detection, and treatment of rhabdomyolysis, since this was a special interest of the HCPU.

a. Injuries.

(1) Injuries in Law Enforcement Officers. This section focuses on injuries in law enforcement offices. It should be noted that FBI new agents are not yet law enforcement officers but rather officers in training and the FBI Academy training environment differs greatly from actual law enforcement activities. Nonetheless, this review was conducted to show the paucity of injury literature relating to law enforcement-related injuries.

(a) Only one study has examined injuries among new law enforcement officers in training, although there were several other studies on veteran law enforcement officers. Sullivan and Shimizu[4] investigated workers' compensation claims for injuries in the Los Angeles County Sheriff's Department. Injuries were defined as "claims [primarily] for strains, sprains, contusions, abrasions, lacerations, fractures, gunshot wounds, bites and trauma". During 4 months of training in 1982, 20% of students filed one or more injury-related workman's compensation claim; 4% of claims resulted in some form of injury-related disability. Compared with male trainees, female trainees' age-adjusted injury claims risk was 2.1 times higher; female trainees' risk of disabling injury claim was 4.3 times higher. There was no association between age and injury rates in either men or women.

(b) This same study[4] also examined other law enforcement officers in the Los Angeles County Sheriff's Department. In 1982, the yearly incidence of workman's compensation claims filed by various subgroups was as follows: patrol deputies or detectives (n=2,428), 30%; deputies on custody or court assignments (n=1,413), 15%; sergeants or higher ranking officers on patrol or detective assignments (n=753), 15%; sergeants or higher ranking officers on custody or court assignments (n=177), 12%. There were no gender differences across the entire group, and injury claim incidence declined with age. The major external causes of the claims were altercations (28%), foreign objects (20%), overexertion (19%), falls (17%), and vehicle crashes (6%). Major injury sites were hand/wrist (23%), back (16%), and knee (10%). Most back injuries were associated with overexertion (which included lifting/lowering, pushing/pulling) and most hand/wrist injuries were associated with altercations.

(c) Three other studies examined injury-related events in veteran law enforcement officers. Suyama et al.[5] examined injury-related workman's compensation claims from public safety providers in an urban center (city not specified in the article) over a 29-month period. The community had 850 policemen, 850 firefighters, and 144 emergency medical technicians (EMTs). During the period, claims incidences were 169 claims/100 EMT, 71 claims/100 police, and 56 claims/100 firemen. Time loss claims were 55 claims/100 EMT, 16 claims/100 police and 16 claims/100 in firemen. EMTs had the highest rates of missed time, 20.1 days/100 EMTs compared with7.7 days/100 firemen and 7.2 days/100 police.

(d) Brown et al.[6] delivered a questionnaire on back pain and factors relating to back pain to a randomly selected sample of Royal Canadian Mounted Police (n=1,002 of 14,897). They found that 55% had reported chronic or recurrent back pain since serving as police officers and only 9% had this problem before joining the force. The 1-year low back pain prevalence was 42%. There was no difference in the prevalence of back pain among those who did and did not wear the duty belt (Sam Browne/Sam Black belts), nor among those who did or did not drive a vehicle.

(e) Nabeel et al.[7] administered a questionnaire to Minneapolis police officers that asked if the officers had experienced back pain, strains, sprains, contusions, lacerations, gunshot wounds, fractures, or chronic pain in the last 12 months. Incidence of reported sprains, back pain, and chronic pain in the last year were 20%, 49% and 26%, respectively.

(2) Injury Rates and Injury Incidence in Military Basic Training.

(a) Basic military training shares some common characteristics with FBI new agent training. Like basic military trainees, new agent trainees live with their fellow trainees in the same barracks, eat in the same cafeteria, and perform all training with their fellow trainees. There are also some differences between FBI new agent training and military basic training. FBI

new agent trainees only train for a limited time during the day (generally 8 hours with additional time for study); military personnel typically have much longer training days, often lasting 12-16 hours with only about 1 hour of personal time each day. The military conducts physical training on an almost daily basis (unless a particular operational training activity is physically demanding like obstacle courses, road marches, and the like). FBI new agents are expected to perform physical training on their own (although they can attend a group training class), and there are 40 physically-demanding defensive tactics sessions included in the new agent training curriculum. Military basic training lasts 6-12 weeks (depending on the service), while FBI new agent training lasts about 21 weeks. It should also be noted that FBI new agents are older (average age about 30 years, compared to about 20 years in military trainees) and better educated (FBI new agents have at least a bachelors degree, while the majority of military trainees are high school graduates).

(b) Cumulative injury incidence (proportion of individuals experiencing one or more injuries) and injury rates (injured trainees per month) have been examined in the basic military training of the United States Army, Navy, Marine Corps, and Air Force.[8-23] These data are shown in Table 1. US Army Basic Combat Training (BCT) was extended from 8 to 9 weeks in October 1998 and thus studies performed before and after this time are separated in Table 1 to reflect the increased time at risk in the latter investigations. Two investigations are included for US Army infantry basic training, which is 12 weeks long.

(c) Direct comparisons of service-specific rates in Table 1 are complicated by the use of different injury collection methods and different injury definitions, even within the same service. With regard to data collection, many investigations examined paper medical records,[13, 14, 20, 24-27] but other studies used electronic medical surveillance systems[9, 22, 23, 28-30] or questionnaires.[15, 31] With regard to injury definitions, most studies have looked at cases where trainees reported to a medical care provider for any type of physical damage to the body,[9, 14, 16, 20, 22, 23, 26, 27, 30] but other studies have included only musculoskeletal injuries[13] or only lower extremity overuse injuries.[13, 25, 32] One study used self-reporting and included any injury regardless of whether or not the trainees sought medical care.[15]

Table 1. Cumulative Injury Incidence and Injury Incidence Rates during Army, Navy, Marine Corps and Air Force Basic Training

Service	Length of Training (weeks)	Study (Reference Number)	Year Data Collected	Recruits (n)		Cumulative Injury Incidence (%)		Injury Incidence Rate (% / month)	
				Men	Women	Men	Women	Men	Women
Army	8 weeks	Kowal 1978[a,33]	1978	347	770	26.2	62.0	13.1	31.0
		Bensel 1983[14]	1980	1,840	644	20.7	41.2	10.4	20.6
		Jones et al. 1993[13]	1984	124	186	27.4	50.5	13.7	25.3
		Bell et al. 2000[24]	1988	509	352	27.0	57.0	13.5	28.5
		Westphal et al. 1995[20]	1994	ND	165	ND	66.7	ND	33.3
		Jones et al. 1996[25]	1996	159	84	41.5	65.5	20.8	32.8
		Knapik et al. 2001[16]	1998	604	305	30.8	58.0	15.4	29.0
	9 weeks	Canham et al. 2000[26]	1998	655	498	29.98	65.3	13.3	29.0
		Knapik et al. 2001[b,27]	2000	682/441	579/554	13.5/16.9	36.1/46.8	6.0/7.5	16.0/20.8
		Knapik et al. 2005[bc,28]	2003	442/569	295/377	19.5/27.9	41.0/47.7	8.7/12.4	18.2/21.2
		Knapik et al. 2008[22]	2007	2,147	915	36.9	64.7	16.4	28.8
	12 weeks (Infantry)	Jones et al. 1993[12]	1988	303	ND	45.9	ND	15.3	ND
		[d]	1996	768	ND	48.0	ND	16.0	ND
US Military Academy	6 Weeks	Bijur et l. 1997[34]	1991	473	85	28.3	61.2	40.8	18.9
Marine Corps	12 weeks	Linenger et al. 1992[35]	1990	8,076	ND	59.7	ND	19.9	ND
		Alamedia et al. 1999[31]	1993	1,143	ND	39.6	ND	14.4	ND
		Shaffer et al. 1999[29]	1995–96	ND	2,766	ND	44.0	ND	14.7
		Almedia et al. 1999[19]	1993–94	176	241	25.6	44.0	9.3	14.7
		Jones et al.	1993	434	366	22.8	53.0	8.3	17.7

Service	Length of Training (weeks)	Study (Reference Number)	Year Data Collected	Recruits (n)		Cumulative Injury Incidence (%)		Injury Incidence Rate (% / month)	
				Men	Women	Men	Women	Men	Women
		1999[36]	1995	396	1,498	29	49	10.5	16.3
			1995	2,546	ND	25	ND	9.1	ND
		Rauh et al. 2006[32]	1999	ND	824	ND	48.5	ND	16.2
		Knapik et al. 2009[30]	2007	840	570	41.7	40.6	15.2	13.5
Navy	9 weeks	Shaffer et al. 1999[29]	1996	ND	8,865	ND	37.2	ND	12.4
Air Force	6 weeks	Snedecor et al. 2000[9]	1994–95	8,660	5,250	16.8	37.8	11.2	25.2
		Knapik et al. 2008[23]	2007	1,979	723	27.6	46.9	18.4	31.3

Legend:
ND = no data collected on this gender

Notes:
[a] Injury data from self-report questionnaire
[b] Cohort study with two groups
[c] Injury data from surveillance system
[d] Previously unpublished data (1998)

(d) Table 2 shows studies that have examined injuries in the basic training of various foreign armies. Most studies involved only men but Heir and Glomsaker[37] and Kerr et al.[38] included women. The study of the Chinese Armed Forces by Wang et al.[39] apparently followed new recruits for one year and likely involved more than just basic training. Wang et al. stated that most injuries occurred in the first 12 weeks, but the cumulative incidence is still lower than for any other type of training regardless of training length. With the exception of Wang et al.[39], monthly overall injury rates varied from 7% to 15%. Differences in injury definitions and differences in specific training environments likely account for at least a portion of these differences.

Table 2. Studies of Foreign Army Basic Training

Study	Situation	Length of Training (weeks)	N	Injury Definition	Cumulative Incidence (%)	Injury Rate (injured trainees/month)
Gordon et al. 1986[40]	South African Basic Training	10	947♂	Acute or overuse event resulting in ≥1 day limited duty	Any: 37.9 Acute: 7.4 Overuse: 32.4	Any: 15.2 Acute: 3.0 Overuse: 13.0
Jordan & Schwellnus 1994[41]	South African Basic Training	10	1,151 ♂	Occurrence due to activity with medical consult and ≥1 day limited duty	31.9[a]	14.1[a]
Heir et al. 1996[37, 42]	Norwegian Conscript Basic Training	Army: 8-10 Air Force: 8-10 Navy: 6-8	Army: 2,379[b] Air Force: 1,519[b] Navy: 2,593[b]	Pain, inflammation, or functional disorder involving musculoskeletal or soft tissue with visit to medical personnel	Army: 27.3 Air Force: 21.6 Navy: 13.0	Army: 12.1[c] Air Force: 9.6[c] Navy: 7.4[c]
Heir and Eide 1997[43]	Norwegian Army Conscript Basic Training	10	480 ♂	Pain, inflammation, or functional disorder involving musculoskeletal or soft tissue with visit to medical personnel	24.4	9.8
Rosendal et al. 2003[44]	Danish Conscript Basic Training	12	349 ♂	Lower extremity events involving pain, inflammation, or functional disorder of musculoskeletal or soft tissue with ≥1 day limited duty	26.4	6.6
Wang et al. 2003[39]	Chinese Armed Forces Police	52	807 ♂	Physical damage to bone, soft tissue or organs with ≥1 day limited duty	13.8	1.2
Kerr 2004[38]	Irish Basic Training	16	354 ♂ 40 ♀	Not clear	♂ 53.1 ♀ 67.5	13.3♂ 16.9 ♀

Notes:
[a]Not clear if cumulative incidence or if incidence of all new injuries (i.e., a person could have been injured more than once)
[b]Authors stated that 1% were women
[c]Nine weeks used in calculation for Army and Air Force; 7 weeks used in calculation for Navy

b. Fitness.

(1) Fitness in Law Enforcement Officers.

(a) Two studies were found on the physical fitness of new law enforcement officers in training. Stamford et al.[45] examined initial and final fitness levels in 54 men and 7 women in a 12-week recruit training program for the Louisville Police Department. Scheduled exercise duration and frequency was at least 1 hour per day, 5 days per week. Physical training emphasized running but also included calisthenics, weight training, and combatives. Before and after training, VO_2max, a measure of aerobic fitness, was measured with a discontinuous cycle ergometer protocol and body fat was determined by densitometry. Initial fitness levels (pre-training) and changes in fitness (post-training) are shown in Table 3. Men increased VO_2max,

and pull-up performance and decreased body fat. Women had more than double the relative improvement of the men and also increased their flexed arm hang performance but had more modest changes in body fat. The greater aerobic improvement of the women was probably due to their lower initial VO_2max, since a number of studies have demonstrated that lower initial aerobic fitness leads to greater relative gains[46]. Fifteen male recruits were retested after one year on duty. The results of the follow-up (obtained from graphs in the article) are shown in Table 4. Results generally show that the officers returned to their pre-training weight, body fat and aerobic fitness, although some upper body strength was retained.

Table 3. Initial Fitness and Changes in Fitness after Louisville Police Officer Recruit Training (values are mean±SD, empty cells data were not provided by the authors)

Variables	Men (n=54)			Women (n=7)		
	Pre-Training	Post-Training	Change (%)	Pre-Training	Post-Training	Change (%)
Age (yrs)	25.2±3.7	-----	-----	24.1±5.1	-----	-----
Height (in)	70.6±1.6	-----	-----	67.5±2.4	-----	-----
Weight (lbs)	180.2±26.0	178.1±23.4	-1.1	137.8±8.4	134.8±8.1	-2.2
Body Fat (%)	17.7±4.5	15.8±3.8	-10.9[a]	25.1±4.1	23.9±3.2	-4.6
VO_2max (ml/kg/min)	36.5±5.8	44.3±5.8	21.3[a]	29.3±4.2	42.7±30	45.7[a]
Pull-Ups (n)	5.2±3.3	6.4±3.8	24.5[a]	-----	-----	-----
Flexed Arm Hang (sec)	----	----	-----	27.3±3.6	30.7±1.9	12.6[a]

Note: [a]Statistically significant change, $p<0.05$

Table 4. Mean Values for Initial Fitness, Changes in Fitness after Police Officer Recruit Training, and Fitness One Year of Active Duty (n=15 men)[a]

Variable	Pre-Training	Post-Training	One Year Active Duty
Weight (lbs)	172	165	174
Body Fat (%)	17.9	16.1	17.2
VO_2max (ml/kg/min)	35.1	50.2	35.5
Pull-Ups (n)	4.5	7.0	6.0

Note: [a]Values are approximate since they were obtained from a graph

(b) Another study of North Carolina law enforcement trainees examined the effectiveness of a health and fitness training program. There were nine groups at two sites over two years. The entire law enforcement training curriculum was 397 hours, 43 hours of which were devoted to the health and fitness training. The health and fitness training course was 12 weeks and included 4 hours of classroom wellness instruction and 3 hours of testing. Exercise sessions were 3 hours each week and involved 20 minutes of aerobic activity (running in groups, cycle ergometers) with muscular endurance/strength training (push-up, sit-up, weight training). As shown in Table 5, body fat was reduced and sit-up performance increased.[47]

Table 5. Initial Fitness and Changes in Fitness after North Carolina Police Officer Recruit Training (values are mean±SD where available, empty cells indicate that data were not provided by the authors)

Variables	Men (n=74-136)			Women (n=17-33)		
	Pre-Training	Post-Training	Change (%)	Pre-Training	Post-Training	Change (%)
Age (yrs)	26.4	-----	-----	26.8	-----	-----
Height (in)	70.4	-----	-----	65.2	-----	-----
Weight (lbs)	189.4±36.5	188.6±34.0	-0.4	150.3±33.4	148.6±30.4	-1.1
Body Mass Index (kg/m^2)	26.5±4.7	26.3±4.2	-0.7	24.5±3.4	24.5±2.9	0.0
Body Fat (%)	17.0±6.9	14.8±6.0	-12.9	27.0±6.9	25.0±7.1	-7.4
Sit-ups (n)	38±9	49±10	28.9	31±7	44±7	41.9

Note: [a]Statistically significant change, $p<0.05$

(c) Besides law enforcement trainees, a number of studies have examined physical fitness among law enforcement officers in active service. Table 6 provides a summary of these investigations and details of the testing methods are listed in the table footnotes. One study on the Greensboro Police Department[48] was excluded from Table 6 because both men (n=9) and women (n=3) were combined in the descriptive statistics and there are major gender differences in performance of fitness events. Pollock et al.[49] performed fitness testing on a large number of police officers in the Dallas and Richardson, Texas, Police Departments. They separated the initial cohort into younger (21-35 years) and older (36-52 years) groups for analysis but only the younger group is shown since they are closer in age to FBI new agent trainees. Rhodes and Farenholtz[50] noted that their subjects were "randomly selected" but they do not specify how the selection was accomplished or where the law enforcement officers were located. Smolander et al.[51] examined the physical fitness of 95 Finnish police officers who were in an officer training course but had been performing police work for at least 7 years. Standish et al.[52] had a mixed group of Royal Canadian Mounted Police recruits and college students, but did not separate the two groups in the descriptive statistics.

Table 6. Selected Fitness Measures on Various Law Enforcement Officers Groups

Measure	Cleveland State University Police, n=15 men[53]	Dallas & Richardson Police n=153 men[49]	Canadian Police[50]		Finnish Police, n=90-95 men[51]	Canadian Police Recruits (n=28) & College Students (n=20)[52]	
			Men (n=78)	Women (n=27)		Men (n=21)	Women (n=27)
Age (years)	29±5	21-35	31±4	28±3	34	24±3	23±2
Weight (kg)	87±15	83±12	86±10	66±9	84±10	75±11	63±9
Height (cm)	179±9	179±6	181±6	168±6	181±5	180±10	170±10
Body Mass Index (kg/m^2)[a]	31.2[a]	25.9[a]	26.3[a]	23.4[a]	25.6[a]	23.9±2.7	22.8±3.4
VO_2max (ml/kg/min)	38.0±6.4[b]	40.7±4.5[b]	44.1±6.7[b]	39.0±6.7[b]	41.2±10.0[h]	ND	ND
1.5 mile Run (min)	ND	ND	ND	ND	ND	11.4±2.1	13.3±3.0
Push-ups (repetitions)	ND	21±8[g]	29±12[c]	11±11[d]	ND	39±14[c]	21±11[c]
Pull-Ups (repetitions)	3.9±2.4	ND	7.8±4.1	1.3±2.1	4.8±3.4	ND	ND
Sit-Ups (repetitions)	33±8[e]	34±6[ef]	33±8[ef]	38±9[ef]	21±3[eg]	47±10[ef]	43±13[ef]

Legend: ND=Not data reported
Notes:
[a]Calculated from height and weight
[b]Graded running treadmill test with oxygen uptake
[c]Continuous until participant could not maintain continuous motion
[d]Continuous until participant could not maintain continuous motion, knees on ground
[e]Bent knee sit-ups
[f]Maximum in 1 minute
[g]Maximum in 30 sec
[h]Estimated from submaximal bicycle ergometer test

c. Associations between Fitness and Injuries.

(1) Law Enforcement Studies.

(a) Two studies examined associations between fitness and injury in law enforcement groups. Nabeel et al.[7] administered a questionnaire to Minneapolis police officers to explore relationships between fitness, physical activity, and injury. The questionnaire asked if the officers had experienced back pain, strains, sprains, contusions, lacerations, gunshot wounds, fractures, or chronic pain in the last 12 months. Questionnaire items also asked about age, height, weight, self-rated fitness, and physical activity. Only selected data on specific association were reported in the article and those data are shown in Tables 7 and 8. Table 7 shows relationships between specific types of pain/injuries and exercise intensity, fitness level, and physical activity. Those with higher self-reported exercise intensity, higher self reported fitness or higher overall physical activity were less likely to report sprains, back pain or chronic pain in the last year. The authors performed a multivariate logistic regression analysis to examine the association between various types of injuries and the other variables. A summary of these data are in Table 8. The selectively reported data showed that: 1) officers with a body mass index (BMI) >35 kg/m^2 were over 3 times more likely to report back pain compared to those with BMI<35 kg/m^2; 2) those exercising less that 30 minutes, 4 times/week were 73%

more likely to report back pain compared with those exercising more than 30 minutes, 4 times/week; 3) those with the lowest level of self-reported fitness were about twice as likely to report back pain and about 75% more likely to report sprains and chronic pain, compared with those with the highest level of self-reported fitness; 4) those in the lowest quartile of physical activity were more likely to report back pain and chronic pain compared with those in the highest quartile of physical activity. The data indicated that higher levels of self-reported fitness, higher levels of physical activity, and lower BMI were associated with lower incidence of specific self-reported injuries.

Table 7. Associations between Injuries and Various Fitness and Physical Activity Variables in Minneapolis Police Officers (Univariate Analysis)

Variable	Level of Variable	Odds Ratios (95% Confidence Intervals)		
		Back Pain	Sprains	Chronic Pain
Exercise Intensity	Low	1.00	1.00	1.00
	High	0.70 (0.50-0.97)	0.82 (0.44-1.50)	0.51 (0.21-1.21)
Self-Reported Fitness	Lowest Level (scale of 4)	1.00	1.00	1.00
	Highest Level (scale of 4)	0.45 (0.27-0.76)	0.40 (0.20-0.83)	0.33 (0.15-0.71)
Calculated Activity Scale	Lowest Quartile	1.00	1.00	1.00
	Highest Quartile	0.60 (0.43-0.82)	0.84 (0.49-1.44)	0.55 (0.32-0.95)

Table 8. Associations between Injuries and Various Fitness and Physical Activity Variables in Minneapolis Police Officers (Multivariate Analysis)

Variable	Level of Variable	Odds Ratios (95% Confidence Intervals)		
		Back Pain	Sprains	Chronic Pain
Body Mass Index	<35 kg/m^2	1.00	ND	ND
	>35 kg/m^2	3.36 (1.17-9.66)		
Exercise	<30 minutes, 4 times/week	1.00	ND	ND
	>30 minutes, 4 times/week	0.27 (0.12-0.65)		
Self-Reported Fitness	Lowest Level (scale of 5)	1.00	1.00	1.00
	Highest Level (scale of 5)	0.48 (0.09-0.88)	0.27 (0.08-0.88)	0.21 (0.06-0.73)
Physical Activity	Lowest Quartile	1.00	ND	1.00
	Highest Quartile	0.37 (0.10-0.73)		0.42 (0.19-0.91)

Legend: ND=No data reported

(b) The second study examining associations between fitness and injury in law enforcement officers included 363 officers in the city of Austin, Texas.[54] The participants were given a fitness assessment that included a maximum treadmill exercise test (Bruce protocol). The outcome measure was medical care claims of any type and included many claims not related to injury. Medical care claims were lower for the more aerobically fit officers, but the differences were not statistically significant (p=0.17). Unfortunately, the risk of a claim was not reported for the different fitness levels. Absenteeism was also examined in this study, but absences due to injuries were specifically excluded from the analysis.

(2) Military Studies.

(a) Associations between injuries and physical fitness have been extensively examined in the military services and studies have involved both basic combat training and operational military units. The basic training studies are shown in Table 9. Regardless of service (Army, Air Force, Marine Corps), higher injury risk was associated with lower aerobic fitness when the latter was measured by VO_2max, 1-mile run, 1.5-mile run, 2-mile run, or 3,000-meter run.[10, 11, 13, 16, 20, 23, 31, 32, 34, 36, 42, 43, 55, 56] Higher injury risk has been associated with less upper body muscular endurance, whether the latter is measured with push-ups, pull-ups, or the flexed arm hang.[12, 13, 16, 20, 30, 57-59] Higher injury risk has been associated with lower abdominal muscular endurance when the latter is measured with sit-ups or crunches.[16, 20, 30, 58, 59]

Table 9. Associations between Levels of Fitness And Injuries in Various Groups of Military Recruits

Study	Group	Injury Case Definition	Fitness Measure	Fitness Levels Being Compared	Risk Ratio (95% Confidence Interval)[a]
Jones, et al 1993[12]	135 ♂ US Army infantry basic trainees	Lower extremity musculoskeletal injury	2-mile run	17.1-22.3 / 11.9-13.8 min	1.6 (0.7-3.4)
			Push-ups	1-16 / 35-57 repetitions	2.0 (1.2-6.0)
Jones et al. 1993[13]	79 ♂ US Amy basic trainees	Physical damage resulting in ≥1 day of limited duty	1-mile run	7.7-11.5 / 5.9-6.4 min	[b]
			Push-ups	4-26 / 36-53 repetitions	4.6 (0.6-36.2)
	140 ♀ US Army basic trainees		1-mile run	10.4-16.3 / 6.0-9.0 min	1.9 (0.8-4.2)
			Push-ups	1-5 / 17-30 repetitions	0.9 (0.4-1.6)
Westphal et al. 1995[20]	159-163 ♀ US Army basic trainees	A traumatic or overuse event resulting in a visit to a medical care provider and ≥1 day limited duty	Push-ups	<2 / >16 repetitions	1.38 (0.86-2.22)
			Sit-ups	<21 / >48 repetitions	1.29 (0.75-2.21)
			2-mile run	>26.5 / <21.0 minutes	1.55 (1.03-2.32)
Canham et al. 1996[57]	156 ♀ US Army basic trainees	Not defined	2-mile run	Slowest quartile/fastest quartile	1.8 (1.1-2.9)
	95 ♂ US Army basic trainees		Push-ups	Lowest performing quartile/highest performing quartile	1.5 (1.0-2.1)
Bijur et al. 1997[34]	437 ♂ US Military Academy Cadets	Overuse or traumatic energy exchange resulting in physical damage and ≥1 day of limited duty	2-mile run	mean 19.6 / mean 12.0 min	3.0
	85 ♀ US Military Academy cadets		2-mile run	mean 15.6 min/mean 12.0 min	1.9

Study	Group	Injury Case Definition	Fitness Measure	Fitness Levels Being Compared	Risk Ratio (95% Confidence Interval)[a]
Heir et al. 1996[42]	912 Norwegian Air Force conscripts	Pain, inflammation, or functional disorder involving musculoskeletal or soft tissue with visit to medical personnel	3000-meter run	14.7-24.0 / 9.4-12.0 min	1.9 (1.2-3.1)
Heir et al. 1997[43]	449 ♂ Norwegian infantry conscripts	Pain, inflammation, or functional disorder involving musculoskeletal or soft tissue with visit to medical personnel	3000-meter run	14.8-23.2 / 10.4-13.3 min	1.5 (1.0-2.3)
Shaffer et al. 1999[56]	1,078 ♂ US Marine Corps recruits	Stress fractures	1.5 mile run	12.3-17.2 / 8.2-10.5 min	3.1 (1.3-7.7)
Knapik et al. 2001[16]	670 ♂ US Army recruits	Physical damage resulting from overuse or trauma	Push-ups	0-22 / 42-86 repetitions	1.8 (1.2-2.8)
			Sit-ups	0-31 / 49-85 repetitions	1.6 (1.0-2.4)
			2-mile run	19.2-31.6 / 10.4-15.4 min	1.6 (1.0-2.4)
			VO_2max	40-47 / 53-70 ml/kg/min	1.9 (1.0-3.7)
	385 ♀ US Army recruits		Push-ups	0-2 / 14-50 repetitions	1.6 (1.1-2.5)
			Sit-ups	0-22 / 45-80 repetitions	1.3 (0.9-2.0)
			2-mile run	23.5-28.7 / 13.0-19.5 min	1.9 (1.2-2.8)
			VO_2max	30-37 / 41-57 ml/kg/min	1.9 (1.1-3.4)
Trank et al. 2001[60]	1,703 ♂ US Naval recruits	Not stated	1.5-mile run	25.5-43.5 / 11.5-17.5 min	1.4 (1.0-1.8)
Rauh et al. 2006[32]	812 ♀ Marine Corps recruits	Lower extremity non-stress fracture overuse injury	1.5-mile run	Slowest quartile/fastest quartile	1.3 (0.9-2.0)
		Stress fracture	1.5-mile run	Slowest quartile/fastest quartile	2.6 (1.2-5.8)
Shaffer et al. 2006[61]	2,767 ♀ Marine Corps recruits	Stress fracture	0.75 or 1-mile run	Slowest quartile/fastest quartile	3.1 (1.3-7.8)
Knapik et al. 2009[58]	1,240-1,330 ♂ US Army recruits	Specific International Classification of Disease, Version 9 codes indicative of physical damage	Push-ups	0-25 / 45-83 repetitions	1.4 (1.1-1.8)
			Sit-ups	0-33 / 52-92 repetitions	1.2 (1.0-1.6)
			2-mile run	20.3-32.2 / 11.7-16.0 min	1.5 (1.2-2.0)
	467-516 ♀US Army recruits		Push-ups	0-4 / 23-62 repetitions	1.9 (1.4-2.6)
			Sit-ups	0-20 / 47-89 repetitions	1.8 (1.3-2.4)
			2-mile run	24.8-31.3 / 12.3-19.4 min	2.2 (1.6-3.0)
Knapik et al. 2010[59]	1,713-1,729 ♂ US Air Force recruits	Specific International Classification of Disease, Version 9 codes indicative of physical damage	Push-ups	0-28 / 46-94 repetitions	1.5 (1.1-1.9)
			Crunch	0-30 / 45-75 repetitions	1.5 (1.2-2.0)
			1.5-mile run	14.0-20.5 / 8.3-11.5 min	1.5 (1.1-1.9)
	680-684 ♀US Air Force recruits		Push-ups	0-7 / 22-101 repetitions	1.3 (0.9-1.7)
			Crunch	0-19 / 33-62 repetitions	1.1 (0.8-1.5)
			1.5-mile run	18.2-31.4 / 9.7-14.9 min	1.6 (1.2-2.2)

Study	Group	Injury Case Definition	Fitness Measure	Fitness Levels Being Compared	Risk Ratio (95% Confidence Interval)[a]
Knapik et al. 2010[62]	782 ♂ US Marine Corps recruits	Specific International Classification of Disease, Version 9 codes indicative of physical damage	Pull-ups	0-4 /12-26 repetitions	1.6 (1.2-2.2)
			Crunch	13-51 / 74-159 repetitions	1.6 (1.2-2.2)
			1.5-mile run	12.0-15.0 / 8.3-10.5 min	2.0 (1.5-2.8)
	566-567 ♀US Marine Corps recruits		Flexed arm hang	5-30 / 59-70sec	1.4 (1.0-1.9)
			Crunch	13-51/ 81-130 repetitions	1.8 (1.2-2.6)
			1.5-mile run	14.8-17.4 / 10.1-13.0 min	1.9 (1.3-2.8)

Notes:
[a]Some authors provided odds ratios or 90% confidence intervals so data were recalculated.
[b]Lowest risk group had no injuries and highest risk group had 36.8%with one or more injuries. Risk ratio cannot be calculated when there are no injuries in a group.

(b) The military studies above examined associations between fitness and injury did not provide injury risk at identical levels of fitness that would allow for the most appropriate comparisons among studies. For example, time to complete a 2-mile run could be partitioned into 9.0-9.9 minutes, 10-10.9 minutes, 11.0-11.9 minutes, etc. and then the injury risk at each time period could be determined. Rather than use a common cutpoint method like this one, most studies partitioned fitness levels into tertiles, quartiles, or quintiles. Using tertiles, quartiles, or quintiles optimizes sample sizes at each fitness level because a maximum number of individuals are included in each grouping, each subject is included, and there are no groups with small sample sizes that might have low statistical power. Despite these advantages for individual studies, this method complicates direct comparisons among studies because different investigations have different tertile/quartile/quintile cutpoints depending on the distribution of scores. Nonetheless, injury comparisons among studies can still be made by paying careful attention to the cutpoints. The largest differences are likely found among the least fit and the most fit (indicated by the two extreme quartiles or quintiles).

(c) Some further issues in direct comparisons across military studies are introduced by examining different fitness tests that presumably measure the same fitness component. For example, both a 1-mile and a 2-mile run are considered measures of cardiorespiratory endurance; however, the 1-mile run will recruit more anaerobic energy sources, will likely make greater use of Type II muscle fibers, and will require more muscular force per stride than a 2-mile run.[63] Nonetheless, both are measures of cardiorespiratory endurance since both have a moderate to high correlation with VO_2max, the criterion measure of aerobic fitness.[64, 65] Besides tests of aerobic fitness, different muscular endurance tests will recruit different muscle groups and some muscle group specificity might be expected because of individual differences in total muscle mass at different sites. Despite this, factor analysis has indicated that push-ups, pull-ups, and the flexed arm hang produce high factor loadings on tests that appear to involve upper body muscular endurance. Sit-ups and holding a half-sit (similar to crunches) produce high factor loading on tests that appear to involve abdominal muscular endurance.[66-68]

(d) With the above limitations in mind, meta-analysis was performed on military studies in Table 9 using a general variance based method.[69] This method uses risk ratios and 95% confidence intervals to produce a summary risk ratio and summary 95% confidence interval representing the pooled results of all the studies. Studies examining upper body muscular endurance and using the push-up, pull-up, or flexed arm hang were combined.[12, 13, 16, 30, 57-59] Studies examining abdominal muscular endurance and using the sit-up or crunch were combined.[16, 30, 58, 59] Studies examining aerobic (cardiorespiratory) endurance and using runs of 1 to 2 miles were combined.[12, 13, 16, 30, 43, 56-60] Studies by Shaffer et al.[61] and part of the study by Rauh et al.[32] were not included since they examined only stress fractures and not the overall incidence of injuries. The study by Bijur et al.[34] could not be included because no confidence intervals were provided in the article. Table 10 shows the results of the meta-analysis. Values in Table 10 for upper body muscular endurance and abdominal muscular endurance are likely overestimated. This is because some studies that likely collected these data[12, 13, 32, 57, 60] did not report the results, possibly because of lack of an association between the measure and injury. More certainty can be placed on the association between injuries and aerobic endurance since all available studies reported these values or the data could be calculated from the information provided.

(e) Table 11shows studies in other military groups other than basic trainees that have also examined associations between fitness and injury. Results for these groups are not as clear as for basic trainees.

Table 10. Summary Risk Ratios and Summary 95% Confidence Intervals for Military Recruit Studies Examining Associations between Fitness and Injuries

Fitness Measure	Summary Risk Ratios – Least Fit Group/Most Fit Group (Summary 95% confidence intervals)	
	Men	Women
Upper Body Muscular Endurance (Push-Up, Pull-Up, Flexed Arm Hang)	1.6 (1.4-1.8)	1.5 (1.3-1.8)
Abdominal Muscular Endurance (Sit-Up, Crunch)	1.4 (1.2-1.6)	1.4 (1.2-1.7)
Aerobic Endurance (Runs - 1.0, 1.5, 2.0 miles; 3000-meter)	1.6 (1.5-1.8)	1.7 (1.5-2.0)

Table 11. Studies of Various Military Groups Examining Associations between Fitness and Injuries

Study	Injury Case Definition	Group	Fitness Measure	Level of Fitness Measure	Risk Ratio (95% Confidence Interval)[a]
Knapik et al. 1990[70]	Any acute or overuse event in the Soldier's medical record in last 6 months	298 ♂ Infantry Soldiers	Push-Ups	Lowest /highest performing quartile	1.2 (0.8-1.7)
			Sit-Ups	Lowest /highest performing quartile	1.9 (1.2-2.8)
			2-Mile Run	Lowest /highest performing quartile	1.6 (1.1-2.4)
Reynolds et al. 1994[71]	Any acute or overuse event in the Soldier's medical record in last year	154 ♂ Infantry Soldiers	Push-Ups	Lowest /highest performing quartile	1.2 (0.7-2.2)
			Sit-Ups	Lowest /highest performing quartile	1.5 (0.9-2.4)
			2-Mile Run	Lowest /highest performing quartile	1.6 (0.8-3.0)
Knapik et al. 1999[72]	An event resulting in physical damage to the body & documented visit to a medical care provider in last 10 months	156-162 ♂ senior US Army officers at the US Army War College	Push-Ups	25-42 / 71-121 repetitions	1.0 (0.8-1.5)
			Sit-Ups	28-47 / 73-103 repetitions	1.2 (0.8-1.8)
			2-Mile Run	16.5-19.6 / 11.6-14.1 min	1.1 (0.8-1.5)
Knapik et al. 2006[73]	An event that resulted in physical damage to the body and documented visit to a medical care provider in last year	104 ♂US Army wheel vehicle mechanics	Push-Ups	35-55 / 71-118 repetitions	0.6 (0.3-1.1)
			Sit-Ups	40-59 / 71-93 repetitions	0.7 (0.4-1.3)
			2-Mile Run	15.3-19.0 / 12.1-14.1 min	0.9 (0.5-1.8)
Knapik et al. 2006[74]	Specific International Classification of Disease, Version 9 codes indicative of physical damage in last year	152-192 ♂ US Army Band Members	Push-Ups	20-39 / 56-112 repetitions	1.4 (1.0-2.1)
			Sit-Ups	29-42 / 66-111 repetitions	1.5 (0.9-2.3)
			2-Mile Run	17.2-18.8 / 12.0-15.2 min	1.5 (1.0-2.2)
		32-44 ♀ US Army Band Members	Push-Ups	13-19 / 28-50 repetitions	0.9 (0.4-1.8)
			Sit-Ups	33-46 / 68-90 repetitions	1.3 (0.7-2.6)
			2-Mile Run	19.3-22.8 / 14.7-17.8 min	1.3 (0.2-1.6)
Knapik et al. 2007[75]	Physical damage to the body with a visit to a medical care provider and ≥1 day limited duty in the last year	643-656 ♂ Infantry Soldiers	Push-Ups	21-51 / 72-100 repetitions	1.3 (0.7-2.2)
			Sit-Ups	34-60 / 77-101 repetitions	2.8 (1.5-5.1)
			2-Mile Run	11.7-13.5 / 15.3-24.5 min	1.9 (1.1-3.2)
Wilkerson et al. 2009[76]	Physical damage to the body with a visit to a medical care provider and ≥1 day limited duty in the last year	576-578♂ British Infantry Soldiers	Push-Ups	21-50 / 65-98 repetitions	1.0 (0.7-1.4)
			Sit-Ups	32-55 / 71-110 repetitions	0.9 (0.7-1.3)
			1.5-Mile Run	10.2-13.7 / 7.4-9.3 min	1.0 (0.7-1.4)

(3) Civilian Studies.

(a) Civilian studies that have examined associations between fitness and injuries have produced mixed results. Interpretation of these studies is complicated by different injury definitions, different subject populations, and variable follow-up times. Univariate analyses of fitness and injury associations that could be used in meta-analyses are seldom provided.

(b) Two studies reported an association between higher fitness and lower injury risk.[77, 78] Cady et al.[77] gave a number of tests to 1,652 Los Angeles County firefighters and subsequently followed them up for workman's compensation claims for back injuries. A "fitness index" was developed that included 1) work (watts) at the end of a 20-minute heart rate controlled test (test protocol not specified), 2) total isometric strength of selected muscle groups, 3) spine rotation flexibility, 4) diastolic blood pressure during exercise at a heart rate of 160 beats per minute, and 5) heart rate 2 minutes after a standardized bicycle exercise. The isometric strength test involved an upright pull but it is not clear if other tests were included. The exercise test apparently involved the workload achieved at a heart rate of 160 beats per minute. Workman's compensation claims for back injuries were subsequently followed but the follow-up period is not stated. The 16% of individuals with the lowest fitness index were 9.9 times (95%CI=2.3-42.0) more likely to file a claim for a back injury than the 16% of individuals with the highest fitness index.

(c) Studnek et al.[78] performed a case-control study of a stratified random sample of 574 nationally registered emergency medical technicians. A questionnaire that was administered asked the technicians to self-rate their physical fitness on a 4-point Likert scale. A year later they were asked if they had experienced any back problems in the last year. Those who self reported fair to poor physical fitness were 2.3 times (95%CI=1.2-4.4) more likely to report a back problem in the follow-up period compared with those reporting excellent physical fitness.

(e) In contrast to the civilian studies reporting that higher injury risk was associated with lower fitness,[77, 78] some civilian studies have found no association between fitness and pain or injuries.[79-81] Battie et al.[80] examined 2,434 industrial workers at the Boeing Seattle plant. A submaximal, graded, walking treadmill test providing an estimated VO_2max was administered to the workers. Over the next 4 years, back problems requiring treatment or surgery were obtained from incident reports or medical claims. Little association between estimated treadmill VO_2max and subsequent back problems was found after controlling for age and gender.

(f) Varstappen et al.[81] administered a battery of fitness tests to 136 physical education students and subsequently followed them for injuries over a 4-year period. Tests included the bent arm hang (arm/trunk static strength), arm pull (static arm strength), vertical jump (leg power), leg lifts (leg/trunk muscular endurance), sit-and-reach (flexibility), 10 X 5-meter sprints (anaerobic capacity), plate tapping (arm speed), and a multi-stage 20-meter shuttle run (cardiorespiratory endurance). Once every 3 weeks over the 4-year period, students recorded any injuries they experienced. Injuries were defined as "physical discomfort sustained during physical activity that hindered the subject practicing sports lessons". Low injury proneness was defined as experiencing <3 injuries in 4 years and high injury proneness was defined as ≥4 injuries in 4 years. Injury proneness showed little relationship with any items on the test battery. Students were very fit to begin with, scoring in the 7th to 10th reference deciles (higher fitness)

for the tests compared with a sedentary reference population. Most physical education students were in the 9th and 10th deciles. This limited the range of scores making it difficult to discriminate among fitness levels and this may account for the lack of relationship between injury proneness and fitness.

(g) Several other studies of free-living individuals have shown that those who are more aerobically fit are *more* likely to become injured.[82-87] All but one of these studies[82] involved individuals who were given an initial fitness test at a preventive medicine clinic (Cooper Clinic, Dallas, Texas) and followed up for self-reported injuries over various time periods. A summary of the Cooper Clinic studies is shown in Table 12. All studies in Table 12 used time to exhaustion on a graded treadmill test (Balke protocol) as the measure of aerobic fitness. Low fit individuals were those in the $\leq 20^{th}$ percentile of treadmill times; moderate fit individuals were those in the 21^{st} to 60^{th} percentile of treadmill times; and high fit individuals were those in $\geq 61^{st}$ percentile of treadmill times. In order to determine risk ratios it was necessary to perform a secondary data analysis on some of the studies. One Cooper Clinic study[87] did not provide adequate information for this purpose and thus is not included in the table. No meta-analysis was performed because the subject populations likely overlapped in many of the studies. It is apparent by examining the last column of Table 12 that those in the high fitness category are at higher injury risk than those in the low fitness category.

Table 12. Studies Examining Associations between Aerobic Fitness and Injuries in Free-Living Individuals

Study	Injury Case Definition	Subjects	Fitness Level	Risk Ratio (95% confidence interval)
Hootman et al. 2001[85]	Self-reported activity-related injury in the last year	4,034 ♂ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 2.38 (1.57-3.61) 4.50 (3.02-6.70)
		967 ♀ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.42 (0.75-2.67) 2.18 (1.19-3.97)
Hootman et al. 2002[84]	Self-reported activity-related injury in the last year resulting in taking medication, consulting physician, or stopping/reducing activity	5,028 ♀ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.27 (0.70-2.36) 1.85 (1.50-2.29)
		1,283 ♀ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.05 (0.73-1.52) 1.41 (1.00-1.99)
Hootman et al. 2002[83]	Self-reported lower extremity injury in the last 5 years after starting a running, walking or jogging program; injury resulted in consulting a physician	2,481 ♂ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.55 (1.16-2.07) 1.94 (1.47-2.56)
		609 ♀ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.12 (0.70-1.79) 1.24 (0.79-1.93)
Colbert et al. 2000[86]	Self-reported activity-related injury in the last year requiring a physician visit	3,056 ♂ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 1.02 (0.62-1.68) 1.62 (1.01-2.59)
		867 ♀ attending preventive medicine clinic (Cooper Clinic)	Low Moderate High	1.00 3.03 (0.77-11.87) 2.73 (0.71-10.45)

(h) One study by Blair et al.[82] did not examine Cooper Clinic clients but rather individuals participating in worksite health promotion programs. A baseline examination included a treadmill test and a sit-up test (repetitions completed in1minute). Those starting an exercise program were asked if they experienced any bone, muscle, or joint injury in the previous year (this may have included more than just activity-related injuries). Discriminate function analysis demonstrated that higher injury risk was associated with higher aerobic fitness (treadmill time) or more sit-ups. Univariate analysis of injury and the fitness measures were not provided.

(4) Comparison of Military and Civilian Studies. There were considerable methodological differences between the military basic training and civilian studies. First, injuries in military basic training studies were obtained from documented events in the medical records; most injuries in the civilian studies (with the exception of Ready et al.[79] and Battie et al.[80]) were obtained from self-reports, which are subject to recall bias. Second, the military basic training environment is much more controlled than that of the civilian studies because of the standardized living, sleeping, eating, and activity conditions mentioned above. These factors are uncontrolled and variable in civilian studies and less controlled in the military outside the basic training environment. The similar physical activity is likely the major factor that allows the

association between fitness and injury to be consistently demonstrated in military basic training studies. Nonetheless, in one study, Hootman et al.[85] controlled for type and duration of physical activity (from self reports) and higher aerobic fitness was still associated with higher injury risk. Third, the majority of individuals in military basic training studies are young (average age about 20 years, range 17 to 35 years), while in the Cooper Clinic studies individuals were older (average age about 40 years, range 20-85 years). As pointed out by Hootman et al.[85], older individuals may have more lifetime injuries that could affect their reporting of current injuries due to either the chronic or recurrent nature of some injuries.

d. Associations between Physical Activity and Injuries.

(1) Aside from the study by Nabeel et al.[7] discussed earlier, no other investigation examined associations between physical activity and injury in law enforcement officers. Nonetheless, several studies were found on self-assessed physical activity among law enforcement officers[54, 88-91] that provided some descriptive information on the amount of physical activity performed. Steinhardt et al.[54] evaluated physical activity among City of Austin, Texas, law enforcement officers from responses on a health risk appraisals (HRA). Responses on the HRA were placed into three categories: 1) little or no physical activity, 2) occasional physical activity, or 3) regular physical activity at least 3 times/week. Table 13 shows the proportion of the officers who fell into each of these categories. Franke and Anderson[91] asked Iowa Department of Public Safety law enforcement officers about the average weekly frequency, duration, and perceived intensity of exercise on a questionnaire. They found that 32% (151 of 470) of officers reported that they performed vigorous exercise at least 20 minutes at least 3 times per week for the last 4 weeks. Remey[89] and Franke et al.[90] reported that 11% of law enforcement officers in 9 states (Iowa, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma) reported no physical activity in the past month, compared with 28% of the general population in the same states using the same survey question (from the Behavioral Risk Factor Surveillance Survey).

Table 13. Austin City Police Self -Reported Physical Activity

Physical Activity	Women (%) (n=80)	Men (%) (n=654)
Little or None	4	10
Occasional	58	48
Regular, ≥ 3times/week	39	42

(2) Table 14 shows studies that have examined the association between injuries and prior physical activity in military groups. All of these studies involved recruits or conscripts in US, Norwegian, or Danish basic training. All studies used questionnaires that asked individuals to provide global assessments of their past physical activity. Injury definitions varied widely as shown in Table 15. Nonetheless, with few exceptions, higher levels of previous physical activity were associated with lower injury risk and in most investigations there was a dose response

relationship: as the amount of previous physical activity increased, injury risk decreased. Several studies[12, 13, 16, 43, 44, 58, 59] used a question developed by Washburn et al. [92] or a modification of that question, that asking individuals to determine on a 5-point Likert scale how physically active they were compared with others of their age and sex. In most of the studies that used that question found that the more physical activity men reported, the less likely they were to get injured [12, 13, 16, 43, 44, 58]; the studies that asked this question of women showed little relationship between self-reported physical activity and injuries.[13, 16, 32, 58, 59] Most studies[12, 32, 56, 58, 59] that asked individuals to self-report their running or exercise frequency showed that as frequency increased, injuries decreased. Generally, the longer an individual had been running, the lower the injury risk.[12, 32, 56, 58, 59]

Table 14. Association between Prior Physical Activity and Injuries in Military Groups

Study	Subjects	Outcome Measure (injury definition)	Physical Activity Measure and Results
Gardner et al. 1988[21]	3,008 ♂ Marine Corps recruits	Stress fractures and stress reactions	Usual physical activity status (%inj) Very Active 0.6 Active 0.9 Average 1.6 Below Average 2.0 Inactive 12.0
Jones et al. 1993[12]	303 ♂ US Army infantry recruits	Lower extremity musculoskeletal injury with a visit to a medical care provider	1. Self assessed physical activity[92] (% inj) More Active 28.9 Average 50.6 Less Active 46.7 2. Running frequency (%inj) ≥4 days/week 20.0 1-3 days/week 37.6 0-≤1 days/week 43.5 3. Running duration previous month (%inj) ≥60 min/week 25.9 <60 min/week 40.4 None 43.0
Jones et al. 1993[13]	124 ♂ and 186 ♀US Army recruits	Musculoskeletal injury with visit to a medical care provider and 1 more days of limited duty	Self assessed physical activity[92] (%inj) Men Women Very Active 3.4 30.7 Active 15.7 33.3 Average 35.1 29.7 Less Active 42.7 30.0
Heir & Eide 1997[43]	475-477 ♂ Norwegian conscripts	Pain, inflammation or functional disorder involving the musculoskeletal system or soft tissue resulting in a visit to a medical provider	1. Self assessed physical activity[92] (inj/100 recruit-months) More Active 9.9 Average 12.1 Less Active 16.7 2. Hours of weekly physical activity (inj/100 recruit-months) >10 hours/week 10.7 3-10 hours/week 12.7 0-2 hours/week 13.9

Study	Subjects	Outcome Measure (injury definition)	Physical Activity Measure and Results
Shaffer et al. 1999[56]	1,286 (Group 1) and 1,078 (Group 2) ♂ US Marine recruits	Stress fractures	1. Frequency of sweating during exercise (% inj) Group 1 Group 2 All/quite a lot 1.6 1.8 Fairly Often 3.6 5.1 Never/occasionally 8.3 6.2 2. Exercise frequency (%inj) ≤2 time/week 6.9 5.1 3 times/week 3.2 3.2 ≥4 times/week 2.6 3.4 3. Months running in past year (%inj) None 5.7 4.0 ≤1 month 5.9 3.7 >3 months 1.6 2.4 2-3 months 2.3 4.4
Knapik et al. 2001[16]	220 ♂ and 184 ♀ US Army recruits	Physical damage to the body for which a medical care provider was consulted	1. Self assessed physical activity[92] (risk ratios & 95%CI) Men Women More active 1.0 (referent) 1.0 (referent) Average 1.0 (0.6-1.9) 1.0 (0.6-1.6) Less active 1.7 (1.0-2.9) 0.7 (0.4-1.2) 2. Exercise/sports frequency (risk ratios & 95%CI) <1 time/week 1.8 (1.0-3.1) 0.8 (0.5-1.5) 1 time/week 1.0 (0.5-1.9) 1.0 (0.5-1.8) ≥2 times/week 1.0 (referent) 1.0 (referent)
Rosendal et al. 2003[44]	330 ♂ Danish Conscripts	Acute injuries – those induced by sudden, forceful, traumatic events; overuse – problems of the musculoskeletal system of insidious onset associated with repetitive physical activity	Self assessed physical activity (% inj) Overuse Inj Acute Inj Well trained 4.5 10.6 Trained 14.4 9.2 Less trained 27.3 10.2 Untrained 43.5 13.0
Shaffer et al. 2006[61]	2957 ♀ US Marine Corps recruits	Stress fracture	1. Self assessed physical activity (% inj) Excellent/very good 3.6 Good 4.8 Fair/Poor 6.9 2. Frequency of sweating during exercise (% inj) Always/quite a lot 4.6 Fairly often 5.0 Never/occasionally 6.0 3. Exercise/sport frequency (% inj) 0-1 day/week 4.8 2-4 days/week 5.3 5-7 days/week 5.0 4. Frequency of running (% inj) None 7.9 1-3 times/week 5.5 ≥4 times/week 3.8 5. Duration of running (% inj) >20 minutes/session 3.7 ≤20 minutes/session 5.3

Study	Subjects	Outcome Measure (injury definition)	Physical Activity Measure and Results
Rauh et al. 2006[32]	824 ♀ US Marine Corps recruits	Lower extremity stress fracture or non-stress fracture overuse injury	1. Frequency of sweating during exercise (% inj) Stress Fx / Non-stress Fx Inj Always/quite a lot 5.6 / 37.9 Fairly often 7.3 / 46.8 Never/occasionally 7.8 / 41.1 2. Exercise frequency (%inj) 5-7 times/week 4.9 / 39.2 2-4 times/week 6.7 / 42.6 0-1 time/week 12.1 / 43.9 4. Running frequency ≥4 times/week 5.9 / 39.0 1-3 times/week 7.2 / 42.8 Nonrunner 7.3 / 43.6 5. Months running in past year (%inj) ≥7 months 4.3 / 36.4 0-6 months 7.5 / 43.1
Knapik et al. 2009[58]	2,144 ♂ and 915 ♀ US Army recruits	ICD-9 codes indicative of overuse or traumatic injury	1. Self assessed physical activity[92] (hazard ratio, 95%CI) Men / Women Much more active 1.0 (referent) / 1.0 (referent) More active 1.0 (0.7-1.3) / 1.1 (0.7-1.7) Average 1.1 (0.8-1.5) / 1.2 (0.7-1.8) Less active 1.2 (0.9-1.6) / 1.5 (0.9-2.0) Much less active 1.7 (1.2-2.4) / 1.5 (0.9-2.4) 2. Exercise/sports frequency (hazard ratio, 95%CI) ≥5 times/week 1.0 (referent) / 1.0 (referent) 2-4 times/week 1.0 (0.9-1.3) / 1.1 (0.9-1.4) ≤1 time/week 1.3 (1.0-1.6) / 1.4 (1.1-1.8) 3. Running/jogging frequency (hazard ratio, 95%CI) ≥5 times/week 1.0 (referent) / 1.0 (referent) 2-4 times/week 1.0 (0.8-1.3) / 1.3 (0.9-1.9) ≤1 time/week 1.3 (1.0-1.7) / 1.6 (1.2-2.3) 4. Length of time running/jogging (hazard ratio, 95%CI) ≥7 months 1.0 (referent) / 1.0 (referent) 4-6 months 1.2 (0.9-1.8) / 1.1 (0.7-1.6) 2-3 months 1.1 (0.9-1.5) / 0.9 (0.7-1.3) ≤1 month 1.1 (0.8-1.5) / 1.2 (0.9-1.6) None 1.6 (1.2-2.1) / 1.3 (1.0-1.9)

Study	Subjects	Outcome Measure (injury definition)	Physical Activity Measure and Results
Knapik et al. 2010[59]	1,432 ♂and 509 ♀ US Air Force recruits	ICD-9 codes indicative of overuse or traumatic injury	1. Self assessed physical activity[92] (hazard ratio, 95%CI) Men Women Much More Active 1.0 (referent) 1.0 (referent) More Active 0.8 (0.6-1.1) 0.9 (0.5-1.6) Average 1.0 (0.8-1.4) 1.2 (0.7-2.0) Less Active 0.9 (0.6-1.4) 1.1 (0.6-1.8) Much Less Active 1.1 (0.7-1.9) 1.2 (0.6-2.3) 2. Frequency of exercise/sports (hazard ratio, 95%CI) ≥5 times/week 1.0 (referent) 1.0 (referent) 2-4 times/week 1.0 (0.8-1.3) 1.2 (0.9-1.8) ≤1 time/week 0.9 (0.6-1.2) 1.2 (0.8-1.9) 3. Frequency of running/jogging (hazard ratio, 95%CI) ≥5 times/week 1.0 (referent) 1.0 (referent) 2-4 times/week 1.1 (0.8-1.6) 1.4 (0.9-2.3) ≤1 time/week 1.0 (0.7-1.4) 1.7 (1.0-2.8) 4. Length of time running/jogging (hazard ratio, 95%CI) ≥7 months 1.0 (referent) 1.0 (referent) 2-6 months 1.1 (0.8-1.6) 1.6 (1.0-2.7) ≤1 month 1.2 (0.8-1.7) 1.6 (1.0-2.6)

Legend: ICD-9=International Classification of Diseases, Revision 9; 95%CI=95% confidence interval; US=United States; %inj=percent injured; inj=injury; Fx=fracture

(3) In contrast to studies on prior physical activity, other studies have shown that as the amount of current physical activity increases, so does injury incidence. Studies have been conducted largely among runners[82, 86, 93-99] but also among athletic club members,[100] military recruits,[12, 31, 101] combinations of runners and walkers,[83-85, 87] and participants in sports and other leisure-time activity.[102, 103] Most of these investigations have used self-reports of injuries and physical activity, although a few studies have documented injuries from medical records,[12, 31, 101] obtained physical activity from training logbooks,[12, 31, 97] or from direct pedometer measurements.[101]

e. Associations between Tobacco Use and Injuries.

(1) No studies were found on the association between cigarette smoking and injuries in law enforcement officers. However, several studies report on the prevalence of cigarette smoking among law enforcement officers. Obtaining prevalence data is complicated by different definitions of smokers and temporal trends in cigarette smoking. Cigarette smoking has declined in the United States over the years 1974 to 1985[104]; more recently (1993-2004), smoking continued to decline among heavy smokers but not among occasional smokers.[105]

(2) Several studies that include smoking prevalence data on law enforcement officers found that 12% to 52% were smokers. Sparrow et al.[106] defined cigarette smoking as men who smoked one or more cigarettes/day and found in 1963 that among 220 police officers in the Boston area, 52% were smokers, compared with 50% among 1428 civilians. Young and

Steinhardt[88] collected data in 1990-1991 and found that 12% of law enforcement officers in the city of Austin, Texas, reported that they currently smoked cigarettes. Franke et al.[90] and Ramey[89] reported in a 1999 survey of officers in nine upper mid-West states that 36% of officers smoked daily in the past 5 years compared with 28% of individuals in the general population. In a sample of 171 male police officers (presumably from Omaha, Nebraska) 22% were smokers, although no definition of smoking was provided.[107]

(3) Despite the lack of data for law enforcement officers, an extensive literature in the military and civilian sector has documented that cigarette smoking is associated with injuries. Cigarette smoking prior to basic training has consistently been associated with increased injury risk in Army and Air Force basic training[12, 16, 22, 23, 108, 109] and in Army basic training in other countries.[43, 110] Further, smoking was associated with injury in infantry soldiers[71] and in other occupational groups.[77, 111-117] Studies showing associations between smoking and injuries in military groups are shown in Table 15.

(4) With regard to the possible mechanisms and the biological plausibility of the association between injury risk and cigarette smoking, there is considerable literature showing associations between smoking, injuries, and psychosocial factors,[118-121] as well as studies showing that cigarette smoking impairs wound healing,[122-126] bone healing,[127-131] tissue strength,[132-137], and immune function. Mechanisms to explain the association between cigarette smoking and injuries have been detailed elsewhere.[22]

Table 15. Association between Cigarette Smoking and Injuries in Military Studies

Study	Subjects	Outcome Measure (injury definition)	Cigarette Smoking Measure and Results
Jones et al. 1993[12]	299 ♂ US Army infantry recruits	Lower extremity musculoskeletal injury with a visit to a medical care provider	Cig/day in last month (% inj) None in Last Year 29.7 None in Last Month 36.7 1-9 cig/day 34.5 10-19 cig/day 52.8 ≥20 cig/day 49.2
Reynolds et al. 1994[71]	181 US ♂ Infantry Soldiers	Clinic visit for a training-related musculoskeletal injury	Cig/day in last year (% inj) None 37.0 1-10 cig/day 59.2 >10 cig/day 64.0
Heir & Eide 1997[43]	480 ♂ Norwegian conscripts	Pain, inflammation or functional disorder involving the musculoskeletal system or soft tissue resulting in a visit to a medical provider	Cig/day in last month (inj/100 recruit-months) None 10.7 1-10 cig/day 11.4 ≥11 cig/day 16.3
Reynolds et al. 2000[138]	239 US Marines in a winter training exercise	Cold injuries-frostnip, frostbite, chilblains	Cig/day in last year (odds ratios & 95%CI) Nonsmoker 1.0 (referent) 1-10 cig/day 1.9 (0.5-7.1) 11-20 cig/day 3.5 (0.7-18.6) >20 cig/day 19.7 (1.8-212.6)

Study	Subjects	Outcome Measure (injury definition)	Cigarette Smoking Measure and Results
Altarac et al. 2000[108]	1089 ♂ and 915 ♀ US Army recruits	Overuse injuries resulting in a visit to a medical care provider	Smoked cig in last month (% inj) Men Women No 24 40 Yes 32 51
Knapik et al. 2001[16]	166 ♂ and 146 ♀ US Army recruits	Physical damage to the body for which the Soldier sought medical care	Cig/day in last year (risk ratios & 95%CI) Men Women Never 1.0 (referent) 1.0 (referent) <11 cig/day 1.6 (0.7-3.9) 1.7 (0.8-3.3) 11-20 cig/day 2.0 (0.9-4.1) 1.8 (0.9-3.5) ≥21 cig/day 2.8 (1.4-5.6) 4.4 (1.9-10.0)
Knapik et al. 2009[30]	821 ♂ and 566 ♀US Marine Corps recruits	ICD-9 codes indicative of overuse or traumatic injury	1. Smoked in last 30 days (hazard ratio & 95%CI) Men Women No 1.00 (referent) 1.00 (referent) Yes 1.26 (1.02-1.57) 1.17 (0.87-1.58) 2. Cig/day in last 30 days (hazard ratio & 95%CI) None 1.00 (referent) 1.00 (referent) 1-9 cig/day 1.26 (0.98-1.61) 1.07 (0.76-1.50) ≥10 cig/day 1.28 (0.93-1.76) 1.57 (0.94-2.63)
Wilkerson et al.2009[76]	644 ♂ British Infantry Soldiers	Physical damage to the body for which the Soldier sought medical care in a one-year period	1. Smoked in last 30 days (hazard ratio & 95%CI) No 1.00 (referent) Yes 1.12 (0.91-1.37) 2. Cig/Day in Last 30 Days None 1.00 (referent 1-9 cig/day 1.14 (0.84-1.54) 10-20 cig/day 1.14 (0.91-1.43) 21-50 cig/day 0.76 (0.36-1.62)
Knapik et al. 2009[58]	2,147 ♂ and 915 ♀ US Army recruits	ICD-9 codes indicative of overuse or traumatic injury	1. Cig/day in last 30 days (hazard ratio & 95%CI) Men Women None 1.00 (referent) 1.00 (referent) 1-19 cig/day 1.20 (1.01-1.42) 1.44 (1.19-1.73) 10-19 cig/day 1.24 (1.01-1.42) 1.49 (1.17-1.89) ≥20 cig/day 1.67 (1.31-2.13) 1.90 (1.34-2.68) 2. Days smoked in last 30 days (hazard ratio & 95%CI) None 1.00 (referent) 1.00 (referent) 1-9 days 0.97 (0.76-1.25) 1.21 (0.91-1.61) 10-19 days 1.14 (0.87-1.50) 1.57 (1.12-2.20) ≥20 days 1.42 (1.22-1.65) 1.58 (1.32-1.88)
Knapik et al. 2010[59]	1,450 ♂ and 514 ♀ US Air Force recruits	ICD-9 codes indicative of overuse or traumatic injury	1. Smoked cig in last 30 days (hazard ratio & 95%CI) Men Women No 1.00 (referent) 1.00 (referent) Yes 1.41 (1.14-1.74) 1.30 (0.97-1.74) 2. Cig/day in last 30 days (hazard ratio & 95%CI) None 1.00 (referent) 1.00 (referent) 1-9 days 1.29 (1.00-1.67) 1.50 (1.05-2.51) ≥10 days 1.47 (1.09-1.99) 1.49 (0.98-2.27)

Abbreviations: ICD-9=International Classification of Diseases, Revision 9; 95%CI=95% confidence interval; US=United States; %inj=percent injured; inj=injury; cig=cigarettes

f. Exertional Rhabdomyolysis.

(1) Rhabdomyolysis is defined as physical damage to striated muscle fibers due to mechanical or metabolic stress that results in the release of muscle cell contents into the circulation. These muscle cell contents may include (but are not limited to) creatine kinase (CK), myoblobin, calcium, potassium, organic acids and proteases. Rhabdomyolysis can be induced by direct physical trauma such as a crushing injury, thrombosis, or electrical shock. It is common in individuals who have metabolic myopathies related to the inability to deliver adequate energy to the muscles (e.g., McArdles disease [inability to utilize muscle glycogen], carnitine palmitoyl transferase deficiency, and phosphofructokinase deficiency). It can be induced by certain drugs or toxins and local invasive infections of muscle may cause it.

(2) Exertional rhabdomyolysis (ER) refers to damage to skeletal muscle induced by excessive physical activity in otherwise healthy individuals. In ER, individuals presumably perform so much activity that they deplete local muscle energy stores. As a result of energy depletion, myocytes are unable to maintain cellular integrity, resulting in cell damage and the release of cellular contents.[139-141]

(3) In ER, the precipitating event is physical activity in excess of that to which the individual is accustomed. There are numerous case reports of ER in the literature associated with military training,[142-149] but also cases during police recruit training[150, 151], in testing of firefighter candidates,[150] in swim training,[152] in bodybuilding,[153, 154] among prison inmates,[155] in school children,[156] and even cases involving personal trainers.[157] Outbreaks involving multiple individuals participating in exercise events have occurred in police,[150] military,[144, 147, 149] athletic training,[152] and in high school physical education.[156] Rhabdomyolysis can occur even in trained athletes if the exercise volume is greater than that normally imposed during training.[152-154, 157]

(4) Risk factors for ER have not been well investigated but a few studies suggest that low levels of prior physical activity, low physical fitness, Black race, and warmer weather increases the likelihood.[150, 158] Studies identifying these risk factors examined fire department candidates, police officer trainees, and military personnel. One outbreak investigation of ER involved candidates testing for admission into the New York City Fire Department. They took a test that involved 11 simulated firefighting tasks while wearing a 20-lb vest and 20-lb oxygen tank. Completion of the tasks in ≤7 minutes was passing and completion in ≤4 minutes provided the highest score. During a 19-month period in which the test was modified four times, there were a total of 16,506 candidates and 32 were hospitalized for rhabdomyolysis (CK ≥600 U/L) or renal impairment (serum creatine ≥3.0 mg/dl). This provided an incidence of 0.2% (32/16,506). Risk was lower among those engaging in prior physical activity (work plus leisure physical activity≥50 hours/week) (OR=0.2, 95%CI=0.1-0.9).[150]

(5) Another outbreak investigation involved 50 police trainees in Western Massachusetts who were involved in a "mental stress test" (not defined in article) and physical training program. The first 3 days of the program involved heavy physical activity (push-ups, squat thrusts, and running) and hydration was likely not adequate during this time. By the third day, 5 trainees had been hospitalized. All 50 trainees had serum CKs ≥10 time normal and 33 had CKs ≥200 times normal (the latter defined a severe rhabdomyolysis). Thirteen of the trainees were eventually hospitalized with CKs ≥32,000 U/L and abnormal urinalysis. Nine of the hospitalized group had serum creatinine ≥ 2.0 mg/ml (defined as renal insufficiency). One trainee died 44 days after onset. One month before the program 49 trainees were administered a 1.5-mile run and sit-up test. Compared to trainees who passed both fitness tests (passing criteria not provided), those who failed either test were at 2.5 times (95%CI=1.3-4.9) higher risk of severe rhabdomyolysis, and 2.0 times (95%CI=0.5-8.8) higher risk of renal insufficiency.[150]

(6) Cases of ER were investigated in the military services from 2004 to 2007 using medical surveillance data. ER was defined as an International Classification of Diseases, Version 9, Clinical Modification (ICD-9-CM) code of 728.88 (rhabdomyolysis) and/or 791.3 (myoglobinuria), plus a diagnosis of 276.5 (volume depletion (dehydration)), and/or 992.0-992.9 (effects of heat) and/or 994.3-994.5 (effects of thirst (deprivation of water), exhaustion due to exposure, and exhaustion due to excessive exertion (overexertion)). The year 2004 was the first year that the ICD-9-CM code for rhabdomyolysis was available. There were 595 incidence cases of presumed ER. Those of "Black, non-Hispanic" race and "other" race were at increased risk relative to "White, non-Hispanics". Eighty four percent of cases occurred in the June to September months (mid to late summer). Thirty seven percent of cases occurred at 9 military bases conducting basic military training.[158]

(7) Diagnosis of ER is based on clinical examination and laboratory finding. Patients typically present with a history of heavy and unaccustomed exercise and with symptoms of severe muscle pain, muscle swelling, weakness, and decreased range of motion. The urine may be dark brown. Pain is often localized to the muscle groups that were excessively exercised. Suggested diagnostic criteria for ER have been developed by the Uniformed Services University Consortium for Health and Military Performance in conjunction with the Israeli Defense Force's Heller Institute. These criteria are 1) a serum CK level five times higher than the upper limit of normal and/or, 2) a urine dipstick positive for blood (due to the presence of myoglobin), but lacking red blood cells under microscopic urinalysis.[159] Two distinct subgroups of ER have been suggested by the consortium. These subgroups are 1) physiologic (benign) ER and 2) clinically relevant ER. Physiological ER is defined as a patient with elevated CK but no other signs or symptoms beyond mild muscle pain expected for the circumstances. This is essentially delayed onset muscle soreness. In clinically relevant ER, the patient presents with severe muscle pain,

muscle swelling, muscle weakness, and myoglobinuria along with the other diagnostic criteria.[159] It is likely that these distinctions are "points" on a continuum ranging from mild to severe muscle damage.

(8) Medical management of ER involves aggressive hydration and correcting electrolyte imbalances. Aggressive hydration replaces fluids that may have been sequestered into the damaged myocytes (as a result of the failure of energy-dependent transcellular pumps) and reduces the probability of acute renal failure by increasing urine flow to assist in removal of myoglobin. Acute renal failure is the most serious complication of rhabdomyolysis and is thought to be due to free myoglobin, which may cause renal vasoconstriction and nephrotoxic effects and/or precipitate to produce renal tubular obstructions (pigmented "casts"). To minimize the possibility of acute renal failure, urine output should be >300 ml/h and urine pH>7.5. Diuretics (e.g., furosemide, mannitol) may be used if necessary to maintain urinary output. Mannitol which increases renal blood flow and glomerular filtration rate, is an osmotic agent that extracts fluids from interstitial compartments (thus reducing hypovolemia, muscle swelling, and nerve compression), and increases urinary flow (reducing myoglobin precipitation). Urine can be alkalinized by the addition of 50-100 mEq of sodium bicarbonate to each liter of administered fluid. The proposed ideal fluid regimen is half isotonic saline (0.45% sodium), to which 75 mmoles/l sodium bicarbonate is added. Although mannitol and bicarbonates are the standard of care for reducing the likelihood of acute renal failure, some studies suggest that their use provides no additional benefit to patients over aggressive hydration with saline alone. Blood urea nitrogen and creatinine can be monitored to indicate renal function. Attention should be directed to monitoring potassium, calcium and phosphate levels to correct hyperkalemia, hypocalcemia, and hypophosphatemia when present. Hyperkalemia and hypophosphatemia result from direct release of potassium and phosphates from muscles. Hypocalcemia is from the buildup of calcium in muscle due to the failure of sodium-calcium exchange.[139-141, 155, 160-163] Recommendations for return to activity have also been proposed.[159] Rehabilitation following the acute phase of ER can be prolonged and a rehabilitation program has been described.[144, 164]

(9) In cases of ER it may be important for the medical care provider to question the patient as to whether or not other individuals performed similar activities. This is a common situation in the military and in some types of FBI new agent training (e.g., point run, physical fitness testing) where training may involve large groups of individuals. There may be other individuals with similar symptoms who have not sought immediate medical care.[149]

(10) Several studies have shown that the exercise-induced rise in serum CK and myoglobin can be reduced by a period of pre-conditioning prior to more intense physical training.[165, 166] This adaptation may be mediated by a training-induced increase in the size and number of mitochondria in the myocytes[167] that can provide additional ATP to assist in

stabilizing cellular walls during exercise. Risk of ER in normal healthy individuals can be reduced by graded, individual pre-conditioning prior to beginning a more strenuous exercise regiment and group exercise. In group activity, exercises of specific muscle groups (common in calisthenics type exercises) should be introduced gradually starting with only a few repetitions, and emphasizing the correct form. Sudden increases in exercise volume should be avoided. Rest and rehydration should be emphasized during training, especially in higher temperatures. Rest and rehydration schedules have been developed for the military and are included in Table 16.

Table 16. Military Fluid and Work Rest Guidelines (WBGT=Wet Globe, Bulb Temperature)

Heat Level	WBGT (^{O}F)	Easy Work		Moderate Work		Hard Work	
		Work/ Rest (min)	Water Intake (qt/h)	Work/ Rest (min)	Water Intake (qt/h)	Work/ Rest (min)	Water Intake (qt/h)
1	78-82	No Limit	0.5	No Limit	0.75	40/20	0.75
2	82-85	No Limit	0.5	50/10	0.75	30/30	1.0
3	85-88	No Limit	0.75	40/20	0.75	30/30	1.0
4	88-90	No Limit	0.75	30/30	0.75	20/40	1.0
5	>90	50/10	1.0	20/40	1.0	10/50	1.0

Montain, Milit Med 164:502, 1999

5. METHODS.

a. FBI New Agent Training.

(1) New agent classes at the FBI academy consisted of a maximum of 50 individuals who together participated in 21 weeks of training. The new agent training curriculum consisted of over 900 hours of training. This included about 114 hours of firearms training, 94 hours of defensive tactics training, and about 95 hours of practical application training. Firearms training included marksmanship (Glock 22, shotgun, MP5, and M-16), close combat skills, and moving in teams with weapons. Defensive tactics involved boxing, self-defense, and suspect apprehension techniques. Practical application training included driver training, conducting

surveillance, entering and clearing rooms, and arresting suspects. New agents were expected to perform physical fitness training on their own, although those who failed the first physical fitness test (PFT) were required to attend group physical training three times per week. These group sessions were conducted on one morning and two afternoons.

(2) FBI new agent classes were numbered with the fiscal year (FY) of the class start date, and the numeric sequence of the class during that FY. Thus, Class 09-09 was the 9th class conducted in FY 2009. The present project followed 12 classes: Class 09-09 through Class 10-01. The first class (09-09) began training on 15 March 2009 and completed training on 5 August 2009. The last class (10-01) began training on 26 October 2009 and completed training on 18 March 2010.

b. Project Design. This project employed a prospective cohort design. Early on the third day of training at the FBI Academy, new agents were informed about the purposes of the investigation. Those who agreed to participate signed a privacy act statement and completed a questionnaire. During the time the new agents were at the FBI Academy they completed one or more PFTs and their scores were obtained. Their injuries were tracked from a database at the FBI Health Clinic, as described below. The project period was about 1 year (March 2009-March 2010).

c. Questionnaire. The questionnaire completed by new agents asked about previous lifestyle behaviors including tobacco use, physical activity, self-assessed physical fitness, prior injuries and (for women) menstrual history. The questionnaire is in Appendix C.

d. Physical Characteristics and Demographics.

(1) On arrival at the FBI Academy, new agents filled out a New Agent Trainee Profile which asked about demographic information. This form is shown in Appendix D. Data extracted from this form included FBI field office (processing office), program under which new agent entered, educational level, marital status, number of children, foreign languages spoken, military experience, law enforcement experience, and dominate hand.

(2) The Standard Form 88 (SF88, Report of Medical Examination) in the new agent medical record was used to obtain information on the new agent's gender, height, weight, race, and date of birth (for age calculation). With the exception of race, these data duplicated some self-reported data on the questionnaire so that the data could be compared. Data on the SF88 was collected by contract physicians in offices close to the FBI field offices as part of the medical examination to determine fitness for duty. The minimum time from the medical examination to entry into the FBI Academy was about six weeks; the maximum might exceed a year. The SF88 is shown in Appendix E

e. Physical Fitness Data.

(1) Physical fitness test (PFT) data were obtained from an existing database in the Physical Training Unit of the FBI Academy. The PFT consisted of four scored events: 1-minute sit-ups, 300-meter run, push-ups to exhaustion, and 1.5-mile run, administered in that order. Pull-ups to exhaustion were also included, but this event was not considered in the total score. At least 5 minutes of rest were provided between events. At the start of the project, PFTs were administered at Weeks 1, 7, and 14 of new agent training. After 3 August 2009, PFTs were administered at Weeks 1, 9, and 18. New agents who passed the second test were not required to take the final test.

(2) For the sit-ups, the new agent lay on his/her back with the tops of the shoulder blades touching the floor. Hands were behind the head with fingers interlaced. The knees were bent at a 90 degree angle with the feet flat on the floor. A partner held the feet in place with the partner's hands at the tongue of the trainee's shoes and the partner's knees on the trainee's toes. To execute a repetition, the new agent raised his/her upper body until the base of the neck was in line with the base of the spine (back was perpendicular to the floor). The new agent then returned to the starting position (i.e., the tops of both shoulder blades must touch the floor) to complete the repetition. This was a timed, 1-minute continuous motion exercise. The number of repetitions correctly executed served as the performance score.

(3) The 300-meter sprint took place on a ¼-mile oval track or on a straight road. The new agent started from a standing position in a small group and ran 300 meters (about 3/4 of one lap) as fast as possible. The performance score was the time to complete the distance.

(4) For the push-up, the new agent began in the front leaning rest position (i.e. hands on the floor one to two hand widths beyond the shoulders and elbows pointed away from the body, arms fully extended, body held straight with the feet no more than three inches apart, and the toes touching the floor). To execute a repetition, the elbows were flexed, the body was lowered toward the floor until the upper arms were parallel to the floor (straight line from center axis of elbow to center axis of shoulder). The new agent completed the repetition by returning to the starting position. This was a continuous motion exercise with no time limit and the test was discontinued when the trainee could no longer continue the motion. The number of repetitions correctly executed served as the performance score.

(5) The 1.5-mile run took place on a ¼-mile oval track. The new agent started from a standing position in a group and ran the distance around the track as fast as possible. The performance score was the time to complete the distance.

(6) For pull-ups, the new agent grasped a horizontal bar with both hands, palms facing away (pronated). The starting position was with the arms fully extended beneath the bar, feet free from touching the ground, and the body motionless. One repetition consisted of raising the body with the arms until the chin was above the bar, with no swinging and then lowering the body until the arms were fully extended. The motion was repeated as many times as possible with no time limit and the number of repetitions served as the event score.

(7) Points were assigned to various levels of performance on each PFT event. Table 17 shows the PFT events and the number of points for each performance level. Passing the test required a score of 12 points, with at least 1 point on each event.

Table 17. Physical Fitness Test Point System[a]

Push-Ups			Sit-Ups			300-Meter Run (sec)		
Points	Men (reps)	Women (reps)	Points	Men (reps)	Women (reps)	Points	Men (sec)	Women (sec)
-2	<20	<4	-2	<32	<30	-2	>55.0	>67.4
0	20-29	5-13	0	32-37	30-34	0	55.0-52.5	67.4-65.0
1	30-32	14-18	1	38	35-36	1	52.4-51.1	64.9-62.5
2	33-39	19-21	2	39-42	37-40	2	51.0-49.5	62.4-60.0
3	40-43	22-26	3	43-44	41-42	3	49.4-48.0	59.9-57.5
4	44-49	27-29	4	45-47	43-46	4	47.9-46.1	57.4-56.0
5	50-53	30-32	5	48-49	47-48	5	46.0-45.0	55.9-54.0
6	54-56	33-35	6	50-51	49-50	6	44.9-44.0	53.9-53.0
7	57-60	36-38	7	52-53	51-52	7	43.9-43.0	52.9-52.0
8	61-64	39-41	8	54-55	53-54	8	42.9-42.0	51.9-51.0
9	65-70	42-44	9	56-57	55-56	9	41.9-41.0	50.9-50.0
10	≥71	≥45	10	≥58	≥57	10	<40.9	<49.9

1.5-Mile Run			Pull-Ups		
Points	Men (min:sec)	Women (min:sec)	Points	Men (reps)	Women (reps)
-2	>13:29	>14:59	0	<2	0
0	13:29-12:25	14:59-14:00	1	2-3	1
1	12:24-12:15	13:59-13:35	2	4-5	2
2	12:14-11:35	13:34-13:00	3	6-7	3
3	11:34-11:10	12:59-12:30	4	8-9	4
4	11:09-10:35	12:29-11:57	5	10-11	5
5	10:34-10:15	11:56-11:35	6	12-13	6
6	10:14-9:55	11:34-11:15	7	14-15	7
7	9:54-9:35	11:14-11:06	8	16-17	8
8	9:34-9:20	11:05-10:45	9	18-19	9
9	9:19-9:00	10:44-10:35	10	≥20	≥10
10	<9.00	<10:35			

[a]12 points are needed to pass the physical fitness test with at least 1 point on each event. Pull-ups are not counted in the total point score.

f. Final Student Status. Data on final student status were obtained from the Training Director's Office at the FBI Academy. The list contained the name of each student who did not graduate with his/her class, the date they left the course, and the reason for not graduating. If a student was not on the list, it was assumed that the student had graduated. Students who did not graduate were listed as either recycle-outs, recycle-ins, conversions, dismissals, or resignations. Recycle-outs were students who were temporarily removed from their class because they were either injured to the extent they could not complete training on time or because they required additional training to pass the course. Recycle-ins were students who were returning to the course after recycling out. Conversions were students who switched from becoming new agents to the administrative arm of the FBI. Dismissals were students who were involuntarily discharged from the FBI. Resignations were students who voluntarily left the FBI.

g. Injury Data.

(1) Medical care providers at the FBI Academy Health Clinic at Quantico, Virginia routinely entered information on medical encounters into a computerized database called Medical Data Base (MDB). USAPHC-trained personnel examined each of the new agent's medical encounters and determined if the encounter was for an injury (defined below) or for other medical care. For each injury encounter, extracted information included the name of the new agent, date of visit, type of visit (new injury visit or follow-up on a previous visit), diagnosis, anatomical location, activity associated with the injury, and final disposition. If no final disposition was provided in the record, it was assumed that the new agent was returned to duty. A "consult" disposition was a referral to another level of care including the FBI Academy physician or another medical clinic. The format used to extract the injury data and the codes are in Appendix F.

(2) In addition to the data in the MDB, injury information was also obtained from the US Department of Labor's, CA-1 form (Federal Employee's Notice of Traumatic Injury and Claim for Continuation of Pay/Compensation). Block 13 on the CA-1 form was used to enhance information regarding the activity associated with the injury. Block 14 on the CA-1 form was used to enhance the injury diagnosis and anatomical location. In some cases injuries were found on the CA-1s that were not listed in the MDB and the CA-1 was the only source of information for the injury. The CA-1 Form is shown in Appendix G.

(3) An injury case was a new agent who sustained physical damage to the body[168] and sought medical care or medical compensation one or more times during the survey period. Injuries were grouped by "type" which was determined from descriptive information in the medical notes and/or CA-1, and by the specific diagnosis. Injury types included 1) overuse injury, 2) traumatic injury, 3) environmental injury, and 4) any injury. Overuse injuries were presumably due to or related to prolonged repetitive energy exchanges, resulting in cumulative

microtrauma. Specific overuse diagnoses included musculoskeletal pain (not otherwise specified), tendonitis, bursitis, fasciitis, muscle injury presumably due to overuse (strain), joint injury presumably due to overuse (sprain), retropatellar pain syndrome, impingement, degenerative joint conditions, and shin splints. A traumatic injury was presumably due to sudden energy exchanges (acute event), resulting in abrupt overload with tissue trauma. Specific diagnoses included pain (due to an acute event), muscle injury due to acute event (strain), joint injury due to an acute event (sprain), dislocation, fracture, blister, abrasion, laceration, contusions, and closed head injury/concussion. An environmental injury was presumably due to exposure to weather, animals, or chemicals, resulting in physical damage to the body. Environmental injury diagnoses included heat-related injuries, animal bites, chemical exposures, and exertion (defined below). The "any injury" type included overuse and trauma diagnoses as described above, but excluded environmental injuries. These consisted primarily of musculoskeletal injuries, but also included dermatological events (e.g., blisters, abrasions, lacerations).

(4) Because of the interest in rhabdomyolysis cases these were defined separately. To be classified as rhabdomyolysis, the medical record had to state "rhabdomyolysis" or "possible rhabdomyolysis", and/or report a CK level exceeding 1,000 U/L.

(5) "Exertion" was defined as an event resulting in the inability to continue physical activity after a strenuous activity bout in conjunction with a medical encounter. This was generally coded as "exertion" in the medical record. Although inability to continue physical activity was the primary and defining symptom, additional symptoms might include syncope, lightheadedness, nausea, and vomiting. While exertion is not an injury as defined above, exertion-related events were included in the analysis because they may be related to physical fitness and, possibly, rhabdomyolysis.

(6) New injuries were first medical encounters with a patient resulting in a particular diagnosis at a particular anatomical location. Follow-up injuries were subsequent medical encounters for the same injury. If follow-up visits occurred, they were used in conjunction with the initial encounter to determine the final diagnosis for a specific injury. Thus, an initial diagnosis could be changed as a result of a more specific diagnosis at a higher level of medical care.

h. Data Analysis.

(1) Six databases were compiled and merged using Excel 2007 and Predictive Analytic Software (PASW), Version 18.0.0. These were data from the 1) questionnaires, 2) New Agent Trainee Profiles, 3) SF88s (demographics from the medical records), 4) physical fitness tests, 5) MDB (injury data), and 6) final student status.

(2) All analyses were performed with PASW, Version 18.0.0. Descriptive statistics (frequencies and percentages) were calculated for student status, injury diagnoses, injury anatomical locations, activities associated with the injury, and final dispositions. For all injury types (any injury, overuse injury, traumatic injury and environmental/other injury), injury incidences were calculated as:

$$[(\text{new agent trainees with} \geq 1 \text{ injury}) \div (\text{total number of new agent trainees})] \times 100\%.$$

Injury incidence rates for all injury types were calculated as:

$$[(\text{new agent trainees with} \geq 1 \text{ injury}) \div (\text{total number of days in training})] \times 1000.$$

(3) Descriptive statistics were also calculated for all other variables. For discrete, nominal, and ordinal variables, frequencies and percentages were calculated. For continuous variables, means and standard deviations (SDs) were calculated. To make comparisons among groups with discrete, nominal, or ordinal variables, the chi-square statistic was used. To make comparisons among groups with continuous variables, t-tests or analysis of variance were used.

(4) Cox regression (a survival analysis technique) was used to examine the association between the time to the first injury (any injury) and independent variables (potential injury risk factors) from the questionnaires, New Agent Trainee Profiles, SF88s, and physical fitness tests. For each analysis, once a subject had an injury, his or her contribution to time in new agent training was terminated. Those who attrited from training had their time censored (i.e., end of time at risk) at the day they left training. All variables were entered into the regression models as categorical variables. Continuous variables were converted to quartiles (four groups of about equal size) or tertiles (three groups of about equal size) based on the distribution of scores. Some nominal and ordinal variables were combined to increase statistical power. Age was categorized into two groups, above and below 30 years of age. For all Cox regressions, simple contrasts were used, comparing the hazard at a baseline level of a variable (defined with a hazard ratio (HR) of 1.00) with other levels of the same variable. Univariate Cox regressions established the individual association between time to first injury and levels of each variable. Variables were included in a multivariate Cox regression if they achieved $p < 0.10$ in the univariate analyses.[169] Multivariate Cox regressions established the effect of multiple risk factors on injury risk.

6. RESULTS.

a. New Agent Classes and Final Student Status.

(1) Table 18 shows the number of new agents in each of the classes who were involved in the project. A total of 531 new agents enrolled in the project, 426 men and 105 women. Three new agents declined to participate.

Table 18. Dates and Numbers of New Agents Enrolled By Class

Date of Briefing and Questionnaire Administration	Date Class Started	Date Class Graduated	Class Number	Number of New Agents Enrolled		New Agents Who Declined Participation
				Men	Women	
19MAR09	16MAR09	5AUG09	09-09	34	8	0
1APR09	30MAR09	19AUG09	09-10	30	11	0
15APR09	13APR09	2SEP09	09-11	36	7	0
29APR09	27APR09	17SEP09	09-12	35	8	0
28MAY09	25MAY09	16OCT09	09-13	39	11	0
10JUN09	8JUN09	29OCT09	09-14	37	10	0
8JUL09	6JUL09	27NOV09	09-15	33	16	0
22JUL09	20JUL09	11DEC09	09-16	31	5	2
5AUG09	3AUG09	28DEC09	09-17	32	4	0
2SEP09	31AUG09	27FEB10	09-19	37	9	1
16SEP09	14SEP09	9FEB10	09-20	39	10	0
28OCT09	27OCT09	18MAR10	10-01	43	6	0

(2) Table 19 shows the number and percentages of students who did and did not complete the new agent course the first time in training. The table also shows recycles, conversions, dismissals and resignations. Recycle-outs presumably entered another class at a later date but were not followed once they left their initial class. Six of the seven students who recycled in were all present at the start of training and all completed the training with the first class they entered during this project. One of the female recycle-in recycled out a second time.

Table 19. New Agents Completing and Not Completing Training

		Men		Women	
		N	%		
Completed Training First Time		376	88.3	70	66.7
Did Not Complete Training First Time		50	11.7	35	33.3
Recycles	Out	33	7.7	31	29.5
	In	4	0.9	3	2.7
Conversions		9	2.1	2	1.9
Dismissals		2	0.5	2	1.9
Resignations		6	1.4	1	1.0

(3) Table 20 shows the proportion of new agents who did not complete training because of injuries, physical fitness, and for other reasons. For the men, 3.1%, 1.6% and 3.1% were recycled for injuries, physical fitness and other reasons, respectively. For women, 4.8%, 1.0% and 23.8% were recycled for injuries, physical fitness, and other reasons, respectively.

Table 20. New Agent Reasons for Not Completing Training (number of new agents)

	Men				Women			
	Recycles	Conversion	Dismissals	Resignations	Recycles	Conversion	Dismissals	Resignations
Injury	13	0	0	0	5	0	0	0
Physical Fitness	7	1	0	0	1	0	0	0
Other Reasons	13	8	2	6	25	2	2	1

b. Descriptive Data on Injuries.

(1) Table 21 shows the number of new injury cases and injury follow-ups by diagnosis. In 28 new injury cases (9% of all cases), injury information was obtained from the CA-1s only (i.e., not from the MDB). Among new injuries, overuse injuries made up 14% of cases while traumatic injuries made up 68% of cases. The diagnoses with the largest number of new injury cases were traumatic sprains (joint injuries), traumatic strains (muscle injuries), and musculoskeletal pain associated with trauma. These three diagnoses accounted for 38% of all new injury cases. Diagnosis of musculoskeletal pain were medical encounters during which an individual reported pain in a specific musculoskeletal location from a traumatic event but no specific diagnosis was found in the record. Among follow-ups for injuries, traumatic sprains (joint injuries), traumatic strains (muscle injuries) and musculoskeletal pain associated with trauma accounted for 48% of all follow-ups.

Table 21. New Agent Injury Cases by Diagnoses

Type	Diagnosis	New Injuries		Follow-Ups	
		N	%	N	%
OVERUSE	Tendonitis	10	3.2	3	6.8
	Bursitis	2	0.6	0	0.0
	Retropatellar pain syndrome	5	1.6	2	4.5
	Muscle injury (overuse)	14	4.4	2	4.5
	Neurological	1	0.3	0	0.0
	Joint injury (overuse)	4	1.3	1	2.3
	Musculoskeletal pain (overuse)	6	1.9	0	0.0
	Shin splints	1	0.3	0	0.0
TRAUMATIC	Muscle injury (traumatic)	39	12.4	5	11.4
	Joint injury (traumatic)	45	14.3	13	29.5
	Musculoskeletal pain (traumatic)	37	11.7	3	6.8
	Dislocation	7	2.2	0	0.0
	Bone Fracture	4	1.3	2	4.5
	Tooth Fracture	2	0.6	0	0.0
	Nasal Fracture	2	0.6	0	0.0
	Abrasion or laceration	33	10.5	2	4.5
	Contusion	33	10.5	4	9.1
	Closed Head Injury/Concussion	11	3.5	4	9.1
ENVIR/ OTHER	General heat-related injury	3	1.0	2	4.5
	Exertion	11	3.5	0	0.0
	Insect bites or stings	33	10.5	1	2.3
	Chemical Burn (OC Spray) [a]	12	3.8	0	0.0
Total Cases		315	100.0	44	100.0

[a]OC=oleoresin capsicum

(2) Table 22 shows the number of new injury cases and follow-ups by anatomical location. Among the new injuries, the head accounted for 19% of cases, the upper body 43% of cases, and the lower body 31% of cases. Among new injury cases, most common anatomical sites of injuries in rank order by number of cases were the knees, eyes, shoulders, fingers, face/lower back, and head. Many of the injuries to eyes were chemical irritation from oleoresin capsicum spray. Among the follow-up cases, the head accounted for 16% of encounters, the upper body 36% of encounters, and the lower body 41% of encounters. Among the follow-up cases, the most common anatomical sites in rank order by number of cases were the ankles, shoulders, head/fingers/knee.

Table 22. New Agent Injury Cases by Anatomic Location

Region	Anatomic Location	New Injuries		Follow-Ups	
		N	%	N	%
Head	Head	16	5.1	4	9.1
	Face	18	5.7	0	0.0
	Ear	2	0.6	2	4.5
	Eye	25	7.9	1	2.3
Upper Body	Neck	13	4.1	1	2.3
	Chest	12	3.8	3	6.8
	Abdomen	3	1.0	0	0.0
	Upper back	1	0.3	0	0.0
	Lower back	18	5.7	1	2.3
	Shoulder	24	7.6	6	13.6
	Elbow	13	4.1	0	0.0
	Upper arm	3	1.0	0	0.0
	Lower arm	4	1.3	1	2.3
	Wrist	7	2.2	0	0.0
	Hand	13	4.1	0	0.0
	Finger	23	7.3	4	9.1
Lower Body	Pelvic region	5	1.6	0	0.0
	Hip	6	1.9	0	0.0
	Posterior thigh (hamstring)	9	2.9	1	2.3
	Anterior thigh (quadriceps)	15	4.8	3	6.8
	Knee	31	9.8	4	9.1
	Calf	6	1.9	0	0.0
	Shin	3	1.0	0	0.0
	Ankle	15	4.8	9	20.5
	Foot	5	1.6	0	0.0
	Toe	2	0.6	1	2.3
Other	Multiple	1	0.3	0	0.0
	Not applicable[a]	14	4.4	2	4.5
	Unknown	8	2.5	1	2.3
Total Cases		315	100.0	44	100.0

[a]Heat injuries and exertion

(3) Table 23 shows the number of new injuries and follow-ups by the training activity associated with the injury. Two activities, defensive tactics and physical fitness training, were associated with 78% of the new injury cases and 86% of the follow-up cases.

Table 23. New Agent Injury Cases by Associated Training Activity

Activity	New Injuries		Follow-Ups	
	N	%	N	%
Defensive Tactics	184	58.4	25	56.8
Physical Fitness Training	63	20.0	13	29.5
Physical Fitness Testing	15	4.8	2	4.5
Firearms Training	8	2.5	0	0.0
Off-Duty, Academy	1	0.3	0	0.0
Off Duty, Not Academy	6	1.9	0	0.0
Operational Skills Training	5	1.6	1	2.3
Sports	1	0.3	0	0.0
Other	6	1.9	0	0.0
Unknown	26	8.2	3	6.8
Total	315	100.0	44	100.0

(4) To further investigate which of the defensive tactics activities was associated with injuries, the notes extracted from the medical records were examined in more detail. In 20% of the defensive tactics cases Bull-in-the-Ring was listed as the activity associated with the injury (n=37). Boxing was listed in 13% of the cases (n=24). Oleoresin capsicum spray was listed in 8% of cases (n=15). Wrestling and groundfighting were each listed in 6% of cases (n=11 for each). Breakfalls were listed in 3% of cases (n=6). These activities accounted for 56% of the defensive tactics cases but this is unlikely to be the full picture because in 30% of cases (n=56) only "defensive tactics" was noted without any other information. (Bull-in-the-Ring is an activity in which one individual [the "bull"] is surrounded in a circle by about 10 others. An individual from the outer circle enters the center and for 20-seconds, the "bull" boxes vigorously with this individual. Once the 20 seconds is up, the individual boxing the "bull" returns to the outer circle and another individual from the outer circle enters the center and immediately begins boxing with the "bull". This continues until all 10 or so individuals from the circle have boxed with the "bull". At that point, another individual from the outer circle enters the center and becomes the "bull" and the process is repeated until all 10 individuals have been the "bull".)

(5) To investigate which of the physical training activities were associated with the largest number of injuries, the notes extracted from the medical records were examined in more detail. In 21% of physical training cases the point run was listed as the activity associated with the injury (n=13). In 17% of the cases, running was listed (n=11). In 10% of the cases, sprinting was listed (n=6). In 8% of cases insect bites were listed (n=5). In 6% of the cases, knuckle push-ups were listed (n=4). These activities accounted for 62% of the physical training- related injury cases.

(6) To investigate which of the 8 firearms activities were associated with injuries we examined these separately. There were 2 contusions, one from a weapons recoil and another unspecified (i.e., only "firearms" was listed in the medical records). There were two tick bites from firing range activities. There was one shoulder strain acquired when firing from the prone

position, one ankle sprain was associated with "going prone at the 25 yard line", 1 musculoskeletal pain "from moving in and out of various positions", and 1 exertion-related event.

(7) Table 24 shows the number of new injury and follow-ups cases by the final disposition. Among new injury cases, the disposition was return to duty or a consult in 88% of cases. Among follow-ups the disposition was return to duty or a consult in 70% of cases. Among follow-ups, the proportion of cases receiving limited duty increased substantially.

Table 24. New Agent Injury Cases by Disposition

Activity	New Injuries		Follow-Ups	
	N	%	N	%
Return to Duty	211	67.0	24	54.5
Limited Duty	25	7.9	13	29.5
Consult	65	20.6	7	15.9
Hospitalized	0	0.0	0	0.0
Other/Unknown	14	4.4	0	0.0
Total	315	100.0	44	100.0

c. Injury Incidence and Injury Rates.

(1) Table 25 shows injury incidence by gender and type. Overall injury incidence (any injury) was slightly higher among the women accounted for by higher incidence of both overuse and traumatic injuries. There were 11 exertion-related events, 10 among the men and 1 among the women.

Table 25. New Agent Injury Incidence by Gender and Type

Injury Type	Injury Incidence (%)		Risk Ratio – Women/Men (95% Confidence Interval)	p-value[a]
	Men	Women		
Any	35.0	41.9	1.20 (0.93-1.55)	0.19
Overuse	5.6	13.3	2.36 (1.27-4.42)	<0.01
Traumatic	31.2	37.1	1.19 (0.90-1.58)	0.25
Exertion	2.3	1.0	0.40 (0.05-3.13)	0.37

[a]Chi-square statistic

(2) Injury incidence rates take into account the time each new agent was involved in training, i.e., time at risk. The men had an average±SD 137±27 days in training while the women had 130±29 days. The total days of training were 58,550 for the men and 13,680 for the women. Table 26 shows the injury incidence rates for men and women and compares them. In consonance with the injury incident results in Table 25, the overall injury incidence rate (any injury) was slightly higher among the women; rates were higher among women for both overuse and traumatic injuries.

Table 26. New Agent Injury Incidence Rates by Gender and Type

Injury Type	Injury Incidence Rates (injuries/1,000 person-days)		Rate Ratio – Women/Men (95% Confidence Interval)	p-value[a]
	Men	Women		
Any	2.54	3.22	1.26 (0.90-1.77)	0.09
Overuse	0.41	1.02	2.50 (1.29-4.83)	<0.01
Traumatic	2.27	2.85	1.26 (0.88-1.79)	0.11
Exertion	0.17	0.07	0.43 (0.05-3.34)	0.20

[a]Chi-square statistic

d. Descriptive Statistics on Physical Characteristics, Demographics, and Questionnaire Variables.

(1) Tables 27 shows the age and physical characteristics of the new agents obtained from the questionnaire, trainee profile, and SF88. While Table 27 shows all available data in all 3 data sets, Table 28 compares the age and physical characteristics data among new agents who had information in all three data sets (94% of new agents). Age was calculated from date of birth on the questionnaire and SF88 but reported as an age in years on the trainee profile. It would be expected that new agents would report being somewhat older in the questionnaire and trainee profile data because those data were collected later than the medical records data. Men were an average of 9.7 months older and women were 11.9 months older in the questionnaire data, compared to the SF88. Average height was about the same in all three sets of data for both men and women. Men reported slightly less average weight on the questionnaire and Trainee Profile compared with the SF88, and consequently the calculated average BMI was slightly lower in the questionnaire and Trainee Profile data. Women's average weight and BMI was very similar in all three data sets.

Table 27. New Agent's Age and Physical Characteristics from Questionnaire, Trainee Profile and SF88

Where Data Obtained	Measure	Men		Women	
		N	Mean±SD	N	Mean±SD
Questionnaire (Self-Reported)	Age (years)	426	31.0±3.2	105	30.1±3.1
	Height (inches)	426	70.8±2.8	105	65.4±2.7
	Weight (pounds)	426	180.3±20.8	105	135.7±17.3
	Body Mass Index (kg/m^2)	426	25.3±2.4	105	22.3±2.2
Trainee Profile (Self-Reported)	Age (years)	424	30.4±3.2	104	29.6±3.1
	Height (inches)	424	70.9±2.6	104	65.4±2.7
	Weight (pounds)	423	180.7±20.8	104	135.7±17.5
	Body Mass Index (kg/m^2)	423	25.3±2.3	104	22.3±2.2
SF88	Age (years)	405	30.1±3.3	99	29.1±3.1
	Height (inches)	404	70.8±2.6	99	65.7±2.8
	Weight (pounds)	403	182.6±22.4	99	136.8±18.6
	Body Mass Index (kg/m^2)	403	25.6±2.6	99	22.2±2.2

Table 28. Comparison of Age and Physical Characteristics of New Agents from Questionnaire, Trainee Profile, and SF88

Measure	Men (n=400-402)				Women (n=98)			
	Mean±SD Questionnaire	Mean±SD Trainee Profile	Mean±SD SF88	p-value[a]	Mean±SD Questionnaire	Mean±SD Trainee Profile	Mean±SD SF88	p-value[a]
Age (years)	30.9±3.2	30.9±3.2	30.1±3.3	<0.01	30.1±3.1	29.6±3.1	29.1±3.1	<0.01
Height (inches)	70.8±2.7	70.9±2.6	70.8±2.6	0.27	65.4±2.7	65.5±2.7	65.7±2.8	0.06
Weight (pounds)	180.4±21.0	180.8±21.0	182.6±22.4	<0.01	135.8±17.2	135.8±17.4	136.8±18.6	0.11
Body Mass Index (kg/m^2)	25.3±2.4	25.2±2.3	25.6±2.6	<0.01	22.3±2.2	22.3±2.2	22.3±2.2	0.83

[a]From one-way analysis of variance

(2) Table 29 shows descriptive data on the lifestyle questionnaire variables. Some new agents did not answer some questions and thus cell sizes do not necessarily add up to the total number of men and women involved in the project. Although 42% of men and 39% of women had smoked at least one cigarette in their lives (Question 10), only 17% of men and 14% of women had smoked 100 cigarettes in their lives (Question 9). Because of the small number of current smokers, Questions 11, 12, and 14 were combined into smokers and nonsmokers. Smokers were defined as anyone smoking one or more cigarettes on one or more days in the last 30 days. Only about 3% of men and women were current smokers. Nineteen percent of men and 15% of women reported that they had quit smoking (Question 13).

(3) Because of the small number of smokeless tobacco users, Questions 15, 16, and 18 were combined into smokeless tobacco users and nonusers. Smokeless tobacco users were defined as anyone using any amount of smokeless tobacco on one or more days in the last 30 days. There were almost twice as many smokeless tobacco users (n=24) as there were smokers (n=13). About 6% of men and 1% of women were current smokeless tobacco users. Eight percent of men and 2% of women reported that they had quit using smokeless tobacco (Question 17).

(4) When asked to self-rate their physical activity, 92% of men and 86% of women reported that they were somewhat more active or much more active than their peers. About 96% of men and 96% of women reported performing aerobic exercise at least 3 times per week in the last 2 months; 80% of men and 91% of women performed aerobic exercise for at least 31 minutes. Weight training was performed at least 2 times per week by 76% of men and 77% of women; 71% of men and 60% of women performed weight training for at least 31 minutes. Fewer new agents played sports, with only 28% of men and 32% of woman reporting this at least once a week in the last two months.

(5) When asked to self rate their endurance, sprint speed, strength, flexibility, push-up performance, sit-up performance, and body fat, the proportion of men who rated themselves as performing greater than average or much greater than average were 78%, 61%, 60%, 39%, 59%,

68%, and 25%, respectively. For women, these values were 72%, 51%, 56%, 43%, 55%, 61%, and 16%, respectively.

(6) Over 60% of men and women reported prior injuries to the lower limbs while 42% of men and 31% of women reported injuries to the upper limbs. Of the prior lower body injuries, over 84% were severe enough to prevent normal activity; among prior upper limb injuries, 81% of men and 72% of women had injuries severe enough to prevent normal activity. Most reported that they had recovered from their prior injuries with only 5% of men and 6% of women reporting that they had not returned to 100% activity after their lower limb injury; 6% of men and 3% of women reported that they had not returned to 100% activity after their prior upper limb injury.

(7) Foot, knee, and back pain limited the activity of 15%, 27% and 20% of men, respectively; Foot, knee, and back pain limited the activity of 23%, 22% and 20% of women, respectively.

(8) Only 2 women (2%) reported not having a menstrual cycle in a 6 month period. Over half had used birth control pills in the last year, while few used other hormonal therapies. Twelve percent of women had been pregnant in the past.

Table 29. Descriptive Data on New Agent Lifestyle Variables (from Questionnaire)

Variable Category	Question[a]	Response Category	Men		Women	
			N	%	N	%
Tobacco Use	Q9. Smoked 100 Cigarettes in Lifetime	No	352	82.6	90	85.7
		Yes	74	17.4	15	14.3
	Q10. Age Smoked First Cigarette	Never Smoked	244	58.0	64	61.0
		6-12 years	15	3.2	2	1.9
		13-17 years	101	23.0	21	20.0
		≥18 years	66	15.8	18	17.1
	Q11. Days smoked in Last 30 Days	Nonsmoker	413	96.9	102	97.1
		Smoked	13	3.1	3	2.9
	Q12. Amount of Cigarettes per Day in Last 30 Days	Nonsmoker	413	96.9	102	97.1
		Smoked	13	3.1	3	2.9
	Q13. If Quit Smoking, How Long Ago	Never Smoked	331	77.7	87	82.9
		Smoker	13	3.1	2	1.9
		Quit 1-24 Months Ago	13	3.1	13	12.4
		Quit ≥24 Months Ago	69	16.2	3	2.9
	Q14. Time Smoking	Nonsmoker	413	96.9	102	97.1
		Smoker	13	3.1	3	2.9
	Q15. Smokeless Tobacco Use Last 30 Days	Users	402	94.4	104	99.0
		Nonusers	24	5.6	1	1.0
	Q16. Amount of Smokeless Tobacco Last 30 Days	Users	402	94.4	104	99.0
		Nonusers	24	5.6	1	1.0

Variable Category	Question[a]	Response Category	Men		Women	
			N	%	N	%
	Q17. If Quit Using Smokeless Tobacco, How Long Ago	Never Used	369	86.6	102	97.1
		Users	24	5.6	1	1.0
		Quit 1-24 Months	16	3.8	1	1.0
		Quit ≥24 Months Ago	17	4.0	1	1.0
	Q18. Time Using Smokeless Tobacco	Users	402	94.4	104	99.0
		NonUsers	24	5.6	1	1.0
Physical Activity	Q19. Self Rating of Physical Activity	Much Less Active	0	0.0	2	1.9
		Somewhat Less Active	6	1.4	1	1.0
		About the Same	30	7.0	12	11.4
		Somewhat More Active	163	38.3	37	35.2
		Much More Active	227	53.3	53	50.5
	Q20. Frequency of Aerobic Exercise in Last 2 Months	Never	0	0.0	0	0.0
		< 1 time/week	0	0.0	0	0.0
		1 time/week	2	0.5	0	0.0
		2 times/week	17	4.0	4	3.8
		3 times/week	124	29.1	25	23.8
		4 times/week	123	28.9	27	25.7
		5 times/week	102	23.9	31	29.5
		6 times/week	48	11.3	16	15.2
		≥ 7 times/week	10	2.3	2	1.9
	Q21. Duration of Aerobic Exercise per Session in Last 2 Months	None	0	0.0	0	0.0
		1-15 minutes	2	0.5	0	0.0
		16-30 minutes	82	19.2	9	8.6
		31-45 minutes	134	31.5	27	25.7
		46-60 minutes	123	28.9	41	39.0
		61-75 minutes	58	13.6	15	14.3
		76-90 minutes	23	5.4	7	6.7
		>90 minutes	4	0.9	6	5.7
	Q22. Frequency of Weight Training in Last 2 Months	Never	40	9.4	10	9.5
		< 1 time/week	32	7.5	7	6.7
		1 time/week	32	7.5	7	6.7
		2 times/week	77	18.1	29	27.6
		3 times/week	127	29.8	34	32.4
		4 times/week	71	16.7	11	10.5
		5 times/week	36	8.5	5	4.8
		6 times/week	11	2.6	2	1.9
		≥ 7 times/week	0	0.0	0	0.0
	Q23. Duration of Weight Training in Last 2 Months	None	39	9.2	11	10.5
		1-15 minutes	17	4.0	8	7.6
		16-30 minutes	67	15.7	23	21.9
		31-45 minutes	108	25.4	24	22.9
		46-60 minutes	133	31.2	29	27.6
		61-75 minutes	44	10.3	4	3.8
		76-90 minutes	13	3.1	2	1.9
		>90 minutes	5	1.2	4	3.8
	Q24. Frequency of Playing Sports Last 2 Months	Never	202	47.4	50	47.6
		< 1 time/week	105	24.6	21	20.0
		1 time/week	69	16.2	20	19.0
		2 times/week	32	7.5	8	7.6

Variable Category	Question[a]	Response Category	Men		Women	
			N	%	N	%
		3 times/week	11	2.6	4	3.8
		4 times/week	5	1.2	2	1.9
		5 times/week	2	0.5	0	0.0
		6 times/week	0	0.0	0	0.0
		≥ 7 times/week	0	0.0	0	0.0
	Q25. Duration of Sports in Last 30 Days	None	210	49.3	52	49.5
		1-15 minutes	9	2.1	1	1.0
		16-30 minutes	34	8.0	6	5.7
		31-45 minutes	37	8.7	9	8.6
		46-60 minutes	73	17.1	23	21.9
		61-75 minutes	24	5.6	6	5.7
		76-90 minutes	18	4.2	1	1.0
		>90 minutes	21	4.9	7	6.7
Fitness	Q26a. Self Rating of Endurance	Far Less Than Average	0	0.0	0	0.0
		Less Than Average	16	3.8	5	4.8
		Average	79	18.5	24	23.1
		Greater Than Average	264	62.0	66	63.5
		Far Greater Than Average	67	15.7	9	8.7
	Q26b. Self Rating of Sprint Speed	Far Less Than Average	3	0.7	0	0.0
		Less Than Average	15	3.5	7	6.7
		Average	148	34.7	45	42.9
		Greater Than Average	209	49.1	48	45.7
		Far Greater Than Average	51	12.0	5	4.8
	Q26c. Self Rating of Strength	Far Less Than Average	1	0.2	2	1.9
		Less Than Average	13	3.1	6	5.8
		Average	156	36.8	38	36.5
		Greater Than Average	212	50.0	52	50.0
		Far Greater Than Average	42	9.9	6	5.8
	26d. Self Rating of Flexibility	Far Less Than Average	4	0.9	2	1.9
		Less Than Average	70	16.4	14	13.3
		Average	187	43.9	44	41.9
		Greater Than Average	136	31.9	36	34.3
		Far Greater Than Average	28	6.6	9	8.6
	26e. Self Rating of Push-Ups	Far Less Than Average	0	0.0	3	2.9
		Less Than Average	21	4.9	9	8.6
		Average	152	35.7	35	33.3
		Greater Than Average	213	50.0	49	46.7
		Far Greater Than Average	40	9.4	9	8.6
	26f. Self Rating of Sit-Ups	Far Less Than Average	1	0.2	0	0.0
		Less Than Average	13	3.1	5	4.8
		Average	124	29.1	36	34.3
		Greater Than Average	231	54.2	52	49.5
		Far Greater Than Average	57	13.4	12	11.4
	26g. Self Rating of Body Fat	Far Less Than Average	46	10.8	3	2.9
		Less Than Average	126	29.6	31	29.5
		Average	148	34.7	54	51.4
		Greater Than Average	77	18.1	12	11.4
		Far Greater Than Average	29	6.8	5	4.8

Variable Category	Question[a]	Response Category	Men		Women	
			N	%	N	%
Prior Injury	Q27. Injured Lower Limb	No	167	39.2	40	38.1
		Yes	259	60.8	65	61.9
	Q28. Did Lower Limb Injury Prevent You from Doing Normal Physical Activity	No Injury	167	39.2	40	38.1
		No	41	9.6	10	9.5
		Yes	218	51.2	55	52.4
	Q29. Returned to Normal Physical Activity Since Lower Limb Injury	No Injury	168	39.4	40	38.1
		No	14	3.3	4	3.8
		Yes	244	57.3	61	58.1
	Q30. Injured Upper Limb	No	248	58.2	73	69.5
		Yes	178	41.8	32	30.5
	Q31. Did Upper Limb Injury Prevent You from Doing Normal Physical Activity	No Injury	248	58.2	73	69.5
		No	34	8.0	9	8.6
		Yes	144	33.8	23	21.9
	Q32. Returned to Normal Physical Activity Since Upper Limb Injury	No Injury	247	58.0	73	69.5
		No	11	2.6	1	1.0
		Yes	168	39.4	31	29.5
Pain Limiting Activity	Q33. Have Foot Pain Limiting Activity Sometime	No	363	85.2	81	77.1
		Yes	63	14.8	24	22.9
	Q34. Have Knee Pain Limiting Activity Sometime	No	313	73.5	82	78.1
		Yes	113	26.5	23	21.9
	Q35. Have Back Pain Limiting Activity Sometime	No	341	80.0	84	80.0
		Yes	85	20.0	21	20.0
Menstrual History	Q36. Age of Menarche	8-11 Years			9	8.7
		12-14 Years			76	73.1
		≥15 Years			19	18.3
	Q37. Menstrual Periods Last Year	1-10 Periods			20	19.2
		11-13 Periods			84	80.8
	Q38. Gone ≥ 6 Months without Menstrual Cycle	No			102	98.1
		Yes			2	1.9
		No Menstrual Period Yet			0	0.0
	Q39. Used Birth Control in Past 12 Months	No			47	45.2
		Yes			57	54.8
	Q40. Used Hormonal Therapy in Past 12 Months	No			97	93.3
		Yes			7	6.7
	Q41. Ever Pregnancy	No			90	88.2
		Yes			12	11.8

[a]Q (with a number) refers to the question number on the lifestyle questionnaire

(9) Some items on the questionnaire required responses on a continuous numeric scale. The average±SD responses for these questions are shown in Table 30. The two women who reported that they no longer used smokeless tobacco reported quitting 1 and 180 months ago.

Table 30. New Agent Questionnaire Variables

Question[a]	Men		Women	
	N	Mean ± SD	n	Mean ± SD
Q10. Age Smoked First Cigarette (years)	182	16.5±3.4	41	16.9±2.7
Q11. Days Smoked in Last 30 Days (# days)	13	5.9±9.3	3	4.3±4.9
Q12. Amount of Cigarettes per Day Over Last 30 Days (cigarettes/day)	13	2.4±2.5	3	5.7±8.1
Q13. If Quit Smoking, How Long Ago (months)	82	101±67	15	91±49
Q14. Time Smoking (years)	13	8.3±8.8	1	9.0
Q15. Smokeless Tobacco Use Last 30 Days (#days)	26	13.1±	1	30
Q16. Amount of Smokeless Tobacco Last 30 Days (cans, plugs, pouches)	26	1.1±0.8	1	0.3
Q17. If Quit Using Smokeless Tobacco, How Long Ago (months)	33	60±61	2	91±127
Q18. Time Using Smokeless Tobacco (years)	26	8.8±4.9	1	5.0
Q22. Age of Menarche (years)			104	13.2±1.6
Q23. Menstrual Periods Last Year (n/year)			104	11.0±2.4
Q26. Time Since Last Pregnancy (months)			12	71.9±40.0

[a]Q (with a number) refers to the question number on the lifestyle questionnaire

(10) Table 31 shows demographic data from the medical examination (SF88) and New Agent Trainee Profiles. Sixty-six percent of the men were married compared with only 34% of the women ($p<0.01$); 43% of men had children, compared with only 13% of women ($p<0.01$). With regard to advanced degrees, 40% of men had master's or doctoral degrees, while 58% of women had these degrees ($p<0.01$).

Table 31. New Agent Demographics from Medical Examination and New Agent Trainee Profile

Variable	Level of Variable	Men		Women	
		n	%	n	%
Race	White	353	80.5	76	72.4
	Hispanic	25	5.9	9	8.6
	Asian	13	3.1	6	5.7
	Black	13	3.1	5	4.8
	American Indian	1	0.5	0	0.0
Married	No	145	34.4	67	65.7
	Yes	276	65.6	35	34.3
Children	None	241	56.8	91	87.5
	1 Child	81	19.0	6	5.8
	2 Children	74	17.5	4	3.8
	3 Children	20	4.7	2	1.9
	4 Children	6	1.4	1	1.0
	5 Children	2	0.5	0	0.0
Entry Program	Accounting/Finance	48	11.7	11	11.1
	Information Technology	32	7.8	4	4.0
	Diversified	130	31.6	34	34.3
	Engineering/Science	33	8.0	12	12.1
	Intelligence	30	7.3	11	11.1
	Language	26	6.3	8	8.1
	Law	28	6.8	16	16.2
	Law Enforcement/Military	51	12.4	3	3.0
	Tactical Recruitment Program	34	8.2	0	0.0
Education	Bachelor of Science	149	35.1	21	20.2
	Bachelor of Arts	105	24.8	23	22.1
	Masters of Arts	32	7.5	18	17.3
	Masters of Science	63	14.9	20	19.2
	Masters of Business Administration	32	7.5	7	6.7
	Masters of Public Administration	6	1.4	0	0.0
	Juris Doctorate	30	7.1	15	14.4
	Doctorate	7	1.7	0	0.0
Foreign Language	No	291	68.6	56	53.8
	Yes	133	31.4	48	46.2
Military Experience	No	248	58.5	86	82.7
	Yes	176	41.5	18	17.3
Law Enforcement Experience	No	326	76.9	84	80.8
	Yes	98	23.1	20	19.2
Dominate Hand	Right	387	91.7	93	93.9
	Left	33	7.8	5	5.1
	Ambidextrous	2	0.5	1	1.0

e. Descriptive Statistics on Physical Fitness Test Scores.

(1) Table 32 shows the initial PFT scores obtained within the first 2-3 days of entry into the FBI Academy. Table 33 shows the initial and Week 7 PFT scores and the changes in scores for individuals who took both tests before 3 August 2009. There were significant improvements

on all tests and the women improved more than the men on a relative (%) basis. For the men, average±SD total points increased from 15.0±6.4 on the initial test to 17.2±4.6 ($p<0.01$) on the Week 7 test, a 14.7% improvement. For the women, average±SD total points increased from 12.0±5.1 on the initial test to 17.3±4.8 ($p<0.01$) on the Week 7 test, a 44.2% improvement.

Table 32. New Agent Initial Physical Fitness Test Scores

	Men			Women		
	N	Mean±SD	Minimum/ Maximum	N	Mean±SD	Minimum/ Maximum
Push-Ups (n)	426	37±9	0/71	105	17±8	0/39
Sit-Ups (n)	426	44±5	28/59	105	42±6	26/51
300-Meter Run (sec)	426	45.9±2.4	40/55	105	56.1±3.0	46/62
1.5-Mile Run (min)	425	11.1±1.0	8.1/15.0	105	12.5±0.9	10.1/14.9
Pull-Ups(n)	424	8.1±4.4	0/22	105	0.7±1.8	0/12
Total Score (points)	426	14.9±5.7	1/37	105	12.4±4.6	2/27

Table 33. Comparison of New Agent Initial and Week 7 Physical Fitness Tests (tests taken before 3 August 2009)

Gender	Week	Push-Ups (repetitions)		Sit-Up (repetitions)		300-Meter Run (sec)		1.5-Mile Run (min)		Pull-Ups (repetitions)	
		N	M±SD	N	M±SD	N	M±SD	N	M±SD	N	M±SD
Men	Week 1	262	36±9	262	44±5	262	46.1±2.6	258	11.2±1.0	246	7.9±4.5
	Week 7	262	39±8	262	49±4	262	45.7±2.5	258	10.8±0.8	246	8.6±4.6
	ΔWeek 1 to 7	3		5		0.4		0.4		0.7	
	ΔWeek 1 to 7 (%)[a]	7.4		11.7		0.9		3.4		8.7	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	
Women	Week 1	72	16±8	72	41±6	72	56.3±3.1	72	12.5±1.0	68	0.9±2.0
	Week 7	72	21±6	72	47±4	72	54.8±3.5	72	12.0±0.9	68	1.2±2.2
	ΔWeek 1 to 7	5		6		1.5		0.5		0.3	
	Δ Week 1 to 7 (%)[a]	28.8		14.3		2.6		3.8		45.9	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	

[a]Calculated as |(Week 7-Week 1/Week 1) X 100%|
[b]Paired t-test

(2) Table 34 shows the initial and week 9 PFT scores and the changes in scores for individuals who took both PFTs after 3 August 2009. There were significant improvements on all tests and the women improved more than the men on both a relative (%) and absolute basis. For the men, average±SD total points increased from 15.1±4.3 on the initial test to 19.8±4.2 ($p<0.01$) on the Week 9 test, a 31.1% improvement. For the women, average±SD total points increased from 13.4±3.5 on the initial test to 19.5±2.6 ($p<0.01$) on the Week 9 test, a 45.5% improvement.

Table 34. Comparison of New Agent Initial and Week 9 Physical Fitness Tests (tests taken after 3 August 2009)

Gender	Week	Push-Ups (repetitions)		Sit-Up (repetitions)		300-Meter Run (sec)		1.5-Mile Run (min)		Pull-Ups (repetitions)	
		N	M±SD	N	M±SD	N	M±SD	N	M±SD	N	M±SD
Men	Week 1	146	38±9	146	45±5	146	45.6±2.2	146	10.9±0.9	146	8.6±4.3
	Week 9	146	41±7	146	50±5	146	44.8±2.0	146	10.5±0.8	146	9.3±4.2
	ΔWeek 1 to 9	3		5		0.8		0.4		0.7	
	ΔWeek 1 to 9 (%)[a]	8.4		10.7		1.8		3.7		7.8	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	
Women	Week 1	26	17±6	26	43±6	26	55.7±2.4	26	12.4±0.8	26	0.3±0.8
	Week 7	26	22±6	26	48±5	26	53.8±2.2	26	11.8±0.7	26	0.6±1.3
	ΔWeek 1 to 9	5		5		1.9		0.6		0.3	
	ΔWeek 1 to 9 (%)[a]	28.7		12.5		3.3		4.1		100.0	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	

[a]Calculated as |(Week 9-Week 1/Week 1) X 100%|
[b]Paired t-test

(3) Table 35 shows the initial, Week 7, and Week 14 PFT scores and the changes in scores. The only new agents required to take the Week 14 test were those who failed the initial and Week 7 tests, so the sample sizes are small. As might be expected, initial scores were lower than for the larger sample (Table 32). There were significant improvements on all tests over the 14 week period and the women improved more than the men on a relative (%) and an absolute basis. For the men, average±SD total points were 11.5±6.3, 10.8±3.1, and 13.9±2.7 on the initial, Week 7, and Week 14 tests, respectively ($p<0.01$), a 20.9% improvement overall. For the women, average±SD total points were 7.3±2.5, 10.2±1.9, and 14.9±3.2 on the initial, Week 7, and Week 14 tests, respectively ($p<0.01$), a 104.1% improvement overall.

Table 35. Comparison of New Agent Initial, Week 7, and Week 14 Physical Fitness Tests

Gender	Week	Push-Ups (repetitions)		Sit-Up (repetitions)		300-Meter Run (sec)		1.5-Mile Run (min)		Pull-Ups (repetitions)	
		N	M±SD	N	M±SD	N	M±SD	N	M±SD	N	M±SD
Men	Week 1	33	29±8	33	41±4	33	47.8±2.5	30	11.6±0.6	29	4.3±3.0
	Week 7	33	28±8	33	46±4	33	47.6±2.3	30	11.3±0.6	29	5.4±2.7
	Week 14	33	33±7	33	48±2	33	47.1±2.6	30	11.1±0.6	29	5.4±3.5
	▲Week 1 to 14	4		7		0.9		0.5		1.1	
	▲Week 1 to 14 (%)[a]	15.1		16.3		1.7		4.1		24.0	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	
Women	Week 1	9	11±7	9	41±5	9	58.8±2.4	9	13.5±1.1	9	0.1±0.3
	Week 7	9	13±4	9	46±3	9	58.2±2.2	9	13.3±1.0	9	0.2±0.4
	Week 14	9	20±7	9	51±3	9	55.4±4.7	9	12.9±0.9	9	1.2±2.9
	▲Week 1 to 14	9		10		3.4		0.6		1.1	
	▲Week 1 to 14 (%)[a]	81.9		23.2		5.7		4.3		1100.0	
	p-value[b]	<0.01		<0.01		<0.01		<0.01		<0.01	

[a]Calculated as |(Week 14-Week 1/Week 1) X 100%|
[b]One-way repeated measures analysis of variance

(4) Table 36 shows the initial, Week 9 and Week 18 PFT scores and the changes in scores. The only new agents required to take the Week 18 test were those who failed the initial and Week 9 tests, so the sample sizes are small. As might be expected, initial scores were lower than for the larger sample (Table 32). For the 7 men, there were significant improvements on the push-ups and sit-ups. While men improved somewhat on Week 9 on the 300-meter and 1.5-mile runs, their 18 week performance was similar to their lower initial performance. In fact, the average point score declined slightly on the 18 week test compared with the 9 week test. For the men, average±SD total points were 11.3±4.4, 15.3±4.4, and 14.9±2.0 on the initial, Week 9, and Week 18 tests, respectively ($p<0.01$), a 31.9% improvement overall (initial to Week 18). Only 1 woman took all three tests. She showed progressive improvements on push-ups and sit-ups but her performance on Week 18 was lower than her performance on Week 9 for the 300-meter and 1.5-mile runs. Her total points were 11, 19, and 17 on the initial, Week 9, and Week 18 tests, respectively, a 54.5% improvement overall (initial to Week 18).

Table 36. Comparison of New Agent Initial, Week 9, and Week 18 Physical Fitness Tests

Gender	Week	Push-Ups (repetitions)		Sit-Up (repetitions)		300-Meter Run (sec)		1.5-Mile Run (min)		Pull-Ups (repetitions)	
		N	M±SD	N	M±SD	N	M±SD	N	M±SD	N	M±SD
Men	Week 1	7	1±2	7	42±5	7	46.7±3.0	7	10.7±1.2	7	5.6±5.4
	Week 9	7	28±2	7	47±3	7	45.7±2.7	7	10.4±0.8	7	7.1±3.3
	Week 18	7	32±3	7	47±3	7	46.3±2.2	7	10.7±0.9	7	6.9±2.7
	ΔWeek 1 to 18	31		5		0.4		0		1.3	
	ΔWeek 1 to 18 (%)[a]	5233.33		12.2		0.9		0.0		23.2	
	p-value[b]	<0.01		<0.01		0.25		0.43		0.32	
Women	Week 1	1	0	1	44	1	58.0	1	12.3	1	0
	Week 9	1	5	1	48	1	53.8	1	11.1	1	0
	Week 18	1	12	1	53	1	54.1	1	12.1	1	0
	ΔWeek 1 to 18	12		9		3.9		0.2		0	
	ΔWeek 1 to 18 (%)[a]	---		20.5		6.7		1.6		0	
	p-value[b]	---		---		---		---		---	

[a]Calculated as |(Week 18-Week 1/Week 1) X 100%|
[b]One-way repeated measures analysis of variance

f. Univariate Associations of Injury with Other Variables.

(1) When hazard ratios were considered, women tended to have a slightly higher risk for any injury compared with the men (HR (women/men)=1.34, 95%CI=0.95-1.87, p=0.09). Table 37 shows the univariate associations between any injury and age, physical characteristics, and physical fitness among male new agents. Higher injury incidence was associated with older age, slower 300-meter sprint time, slower 1.5-mile run time, and fewer total PFT points. Those with body mass indices in the third quartile (between about 25 and 27 kg/m^2) tended to have higher injury risk than those with lower BMI but risk was lower in the highest BMI quartile. Note that injury risk was elevated in the lower performing quartiles for all the physical fitness measures, regardless of statistical significance.

Table 37. Univariate Associations between Injury Risk and Age, Physical Characteristics, and Physical Fitness among Male New Agents

Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Age	24.4-29.9 Years	188	26.6	1.00	Referent
	30.0-38.6 Years	238	41.6	1.83 (1.30-2.57)	<0.01
Height	57-69 inches	123	35.0	1.02 (0.69-1.51)	0.93
	70 inches	73	30.1	0.79 (0.48-1.28)	0.34
	71 inches	65	38.5	1.10 (0.69-1.75)	0.70
	72-81 inches	165	35.8	1.00	Referent
Weight	114-167 pounds	109	33.9	1.00	Referent
	168-180 pounds	127	33.1	0.98 (0.61-1.57)	0.91
	181-195 pounds	99	32.3	0.98 (0.61-1.57)	0.92
	196-250 pounds	91	41.8	1.24 (0.79-1.95)	0.35
Body Mass Index	16.51-23.74 kg/m^2	108	34.3	1.00	Referent
	23.75-25.11 kg/m^2	110	25.5	0.74 (0.46-1.22)	0.24
	25.12-26.63 kg/m^2	103	48.5	1.54 (1.00-2.36)	0.05
	26.64-38.74 kg/m^2	105	32.4	0.95 (0.60-1.52)	0.84
Pull-Ups	0-4 repetitions	94	41.5	1.12 (0.72-1.75)	0.62
	5-8 repetitions	138	33.3	0.85 (0.55-1.31)	0.46
	9-11 repetitions	92	27.2	0.64 (0.39-1.06)	0.08
	12-22 repetitions	100	38.0	1.00	Referent
Push-Ups	1-31 repetitions	104	37.5	1.20 (0.76-1.91)	0.44
	32-36 repetitions	112	40.2	1.38 (0.88-2.16)	0.16
	37-42 repetitions	106	30.2	0.97 (0.60-1.58)	0.91
	43-71 repetitions	104	31.7	1.00	Referent
Sit-Ups	28-40 repetition	97	42.7	1.32 (0.83-2.09)	0.23
	41-44 repetitions	132	34.0	1.05 (0.65-1.68)	0.84
	45-47 repetitions	101	29.5	0.84 (0.53-1.34)	0.46
	48-59 repetitions	96	35.6	1.00	Referent
300-Meter Sprint	40-44 seconds	123	28.5	1.00	Referent
	45-46 seconds	132	34.1	1.23 (0.79-1.91)	0.36
	47-48 seconds	108	39.8	1.48 (0.95-2.32)	0.08
	49-55 seconds	63	41.3	1.71 (1.03-2.84)	0.04
1.5-Mile Run	8.18-10.35 minutes	108	25.9	1.00	Referent
	10.36-11.10 minutes	107	30.8	1.24 (0.75-2.05)	0.41
	11.11-11.64 minutes	104	37.5	1.60 (0.99-2.61)	0.06
	11.65-15.02 minutes	106	45.3	2.06 (1.30-3.29)	<0.01
Physical Fitness Test Score	1-11 points	114	43.0	1.73 (1.09-2.75)	0.02
	12-14 points	107	30.8	1.15 (0.70-1.91)	0.58
	15-18 points	108	36.1	1.35 (0.82-2.17)	0.24
	19-37 points	97	28.9	1.00	Referent

(2) Table 38 shows the univariate associations between any injury and age, physical characteristics, and physical fitness among female new agents. Because 74% of the women could not perform a single pull-up, this variable was separated into those who could and who could not perform at least one pull-up. Higher injury incidence was associated with slower 300-meter sprint time, slower 1.5-mile run time, and fewer total PFT points. There was little

association between injury risk and the physical characteristics. Similar to the men, injury risk was elevated in the lower performance quartiles for all the physical fitness measures, regardless of statistical significance.

Table 38. Univariate Associations between Injury Risk and Age, Physical Characteristics, and Physical Fitness among Female New Agents

Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Age	24.1-29.9 years	60	36.7	1.00	Referent
	30.0-37.0 years	45	48.9	1.52 (0.84-2.75)	0.16
Height	58-64 inches	39	46.2	1.49 (0.72-3.10)	0.28
	65-66 inches	31	45.2	1.45 (0.67-3.14)	0.35
	67-71 inches	35	34.3	1.00	Referent
Weight	105-125 pounds	35	42.9	1.00	Referent
	126-140 pounds	35	45.7	1.15 (0.57-2.33)	0.70
	141-200 pounds	35	37.1	0.91 (0.43-1.91)	0.80
Body Mass Index	18.25-21.26 kg/m^2	37	43.2	1.00	Referent
	21.27-23.30 kg/m^2	34	44.1	1.13 (0.56-2.29)	0.73
	23.31-29.54 kg/m^2	34	38.2	0.93 (0.45-1.94)	0.85
Pull-Ups	0 repetitions	78	43.6	1.17 (0.58-2.37)	0.66
	1-12 repetitions	27	37.0	1.00	Referent
Push-Ups	0-13 repetitions	36	50.0	1.38 (0.67-2.81)	0.38
	14-20 repetitions	35	37.1	0.95 (0.44-2.04)	0.89
	21-39 repetitions	34	38.2	1.00	Referent
Sit-Ups	26-40 repetition	38	42.1	1.28 (0.61-2.71)	0.52
	41-44 repetitions	34	47.1	1.44 (0.68-3.05)	0.34
	45-51 repetitions	33	36.4	1.00	Referent
300-Meter Sprint	46-55 seconds	42	35.7	1.00	Referent
	56-58 seconds	41	39.0	1.17 (0.58-2.37)	0.66
	59-62 seconds	22	59.1	2.23 (1.06-4.70)	0.04
1.5-Mile Run	10.05-12.06 minutes	35	40.0	1.00	Referent
	12.07-12.95 minutes	35	37.1	0.90 (0.42-1.92)	0.80
	12.96-14.92 minutes	35	62.9	1.95 (1.00-3.80)	0.05
Physical Fitness Test Score	2-10 points	38	47.4	2.04 (1.00-4.14)	0.05
	11-14 points	32	43.8	1.77 (0.84-3.71)	0.13
	15-27 points	35	34.3	1.00	Referent

(3) Table 39 shows the univariate associations between any injury and tobacco use, physical activity, self-reported fitness, prior injury, and pain limiting activity in the male new agents. Smoking in the past 30 days was not associated with injury risk. On the other hand, those who had smoked 100 cigarettes in their lifetime, had smoked their first cigarette at an older age, or had quit smoking more than 24 months ago were at *lower* injury risk. Smokeless tobacco use in the past 30 days was not associated with injury risk.

(4) Higher injury risk was associated with a lower self rating of physical activity and a lower frequency of aerobic exercise in the past 2 months. Although not statistically significant, higher injury risk was associated with a lower frequency of weight training. Interestingly, longer

duration of aerobic exercise was associated with higher injury risk and a similar (though not statistically significant) trend was seen for weight training duration.

(5) Higher injury risk was associated with a lower self-rating of endurance. Those rating themselves as having average sit-up performance tended to have lower injury risk than those who rated themselves as having greater than average performance. A similar trend was seen for push-up performance.

(6) Men who reported a prior upper or lower limb injury tended to be at higher injury risk. If the men reported that injury to either limb prevented physical activity for at least 1 week, the risk of injury during new agent training was also elevated. If the men had not returned to normal activity after either limb injury, injury risk during new agent training was further elevated.

(7) Men who reported having foot or knee pain that limited activity were at elevated injury risk. Back pain limiting activity also elevated injury risk but less so than foot or knee pain.

Table 39. Univariate Associations between Injury Risk and Questionnaire Variables among Male New Agents

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Tobacco Use	Q9. Smoked 100 Cigarettes in Lifetime	No Yes	352 74	36.9 25.7	1.00 0.63 (0.40-1.03)	Referent 0.07
	Q10. Age Smoked First Cigarette	Never Smoked 6-17 years ≥18 years	244 116 66	41.4 26.7 25.8	1.00 0.56 (0.37-0.84) 0.56 (0.34-0.94)	Referent <0.01 0.03
	Q11. Days smoked in Last 30 Days	Nonsmoker Smoked	413 13	34.9 38.5	1.00 1.04 (0.42-2.56)	Referent 0.92
	Q12. Cigarettes per Day in Last 30 Days	Nonsmoker Smoked	413 13	34.9 38.5	1.00 1.04 (0.42-2.56)	Referent 0.92
	Q13. If Quit Smoking, How Long Ago	Never Smoked Smoker Quit 1-24 Months Ago Quit ≥24 Months Ago	331 13 13 69	36.9 38.5 38.5 24.6	1.00 0.97 (0.40-2.38) 0.92 (0.38-2.25) 0.62 (0.37-1.03)	Referent 0.95 0.86 0.06
	Q14. Time Smoking	Nonsmoker Smoker	413 13	34.9 38.5	1.00 1.04 (0.42-2.56)	Referent 0.92
	Q15. Smokeless Tobacco Use Last 30 Days	Nonusers Users	402 24	35.1 33.3	1.00 0.92 (0.45-1.88)	Referent 0.82
	Q16. Amount of Smokeless Tobacco Last 30 Days	Nonusers Users	402 24	35.1 33.3	1.00 0.92 (0.45-1.88)	Referent 0.82

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
	Q17. If Quit Using Smokeless Tobacco, How Long Ago	Never Used	369	35.2	1.00	Referent
		Users	24	33.3	0.92 (0.45-1.87)	0.81
		Quit 1-24 Months	16	31.3	0.80 (0.33-1.96)	0.63
		Quit ≥24 Months Ago	17	35.3	1.05 (0.46-2.37)	0.92
	Q18. Time Using Smokeless Tobacco	Users	402	35.1	1.00	Referent
		NonUsers	24	33.3	0.92 (0.45-1.88)	0.82
Physical Activity	Q19. Self Rating of Physical Activity	Less Active	6	83.3	4.60 (1.88-11.26)	<0.01
		About the Same	30	26.7	0.75 (0.37-1.52)	0.42
		More Active	390	34.9	1.00	Referent
	Q20. Frequency of Aerobic Exercise in Last 2 Months	≤ 1 time/week	2	100.0	5.96 (1.44-24.69)	0.01
		2-4 times/week	264	31.4	0.75 (0.54-1.03)	0.08
		≥5 times/week	160	40.0	1.00	Referent
	Q21. Duration of Aerobic Exercise Last 2 Months	0-30 minutes	84	34.5	0.73 (0.45-1.19)	0.02
		31-60 minutes	257	32.3	0.70 (0.48-1.03)	0.07
		≥61 minutes	85	43.5	1.00	Referent
	Q22. Frequency of Weight Training in Last 2 Months	≤ 1 time/week	104	40.4	1.40 (0.78-2.52)	0.26
		2-4 times/week	275	33.5	1.06 (0.61-1.83)	0.84
		≥5 times/week	47	31.9	1.00	Referent
	Q23. Duration of Weight Training in Last 2 Months	0-30 minutes	123	33.3	0.80 (0.49-1.31)	0.38
		31-60 minutes	241	34.0	0.78 (0.50-1.22)	0.28
		≥61 minutes	62	41.9	1.00	Referent
	Q24. Frequency of Playing Sports Last 2 Months	≤ 1 time/week	376	35.4	0.61 (0.09-4.36)	0.62
		2-4 times/week	48	31.3	0.50 (0.07-3.82)	0.51
		≥5 times/week	2	50.0	1.00	Referent
	Q25. Duration of Sports in Last 30 Days	0-30 minutes	253	36.8	1.01 (0.64-1.59)	0.97
		31-60 minutes	110	30.0	0.79 (0.46-1.35)	0.39
		≥61 minutes	63	36.5	1.00	Referent
Physical Fitness	Q26a. Self Rating of Endurance	Less Than Average	16	68.8	1.70 (1.45-5.01)	<0.01
		Average	79	36.7	1.15 (0.76-1.73)	0.51
		Greater Than Average	331	32.9	1.00	Referent
	Q26b. Self Rating of Sprint Speed	Less Than Average	18	38.9	1.23 (0.57-2.65)	0.60
		Average	148	35.1	0.99 (0.71-1.40)	0.97
		Greater Than Average	260	34.6	1.00	Referent
	Q26c. Self Rating of Strength	Less Than Average	14	35.7	1.07 (0.43-2.63)	0.89
		Average	156	34.6	1.01 (0.72-1.41)	0.98
		Greater Than Average	254	35.0	1.00	Referent
	Q26d. Self Rating of Flexibility	Less Than Average	74	36.5	0.92 (0.59-1.45)	0.72
		Average	187	31.6	0.80 (0.56-1.14)	0.22
		Greater Than Average	164	37.8	1.00	Referent
	Q26e. Self Rating of Push-Up Performance	Less Than Average	21	52.4	1.43 (0.77-2.57)	0.26
		Average	152	28.9	0.75 (0.52-1.07)	0.11
		Greater Than Average	253	37.2	1.00	Referent
	Q26f. Self Rating of Sit-Up Performance	Less Than Average	14	35.7	0.98 (0.40-2.41)	0.97
		Average	124	29.0	0.70 (0.48-1.02)	0.07
		Greater Than Average	288	37.5	1.00	Referent
	Q26g. Self Rating of Body Fat	Less Than Average	172	37.2	1.28 (0.83-1.95)	0.26
		Average	148	35.8	1.23 (0.79-1.91)	0.36
		Greater Than Average	106	30.2	1.00	Referent

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Prior Injury	Q27. Prior Lower Limb Injury	No	167	29.3	1.00	Referent
		Yes	259	38.6	1.45 (1.03-2.04)	0.03
	Q28. Lower Limb Injury Prevented Normal Physical Activity for ≥1 week	No Injury	167	29.3	1.00	Referent
		No	41	34.1	1.17 (0.65-2.12)	0.60
		Yes	218	39.4	1.51 (1.06-2.14)	0.02
	Q29. Returned to Normal Physical Activity Since Lower Limb Injury	No Injury	168	29.8	1.00	Referent
		No	14	64.3	2.97 (1.46-6.05)	<0.01
		Yes	244	36.9	1.35 (0./95-1.91)	0.09
	Q30. Injured Upper Limb	No	248	31.0	1.00	Referent
		Yes	178	40.4	1.38 (1.00-1.88)	0.05
	Q31. Upper Limb Injury Prevented Normal Physical Activity for ≥1 Week	No Injury	248	31.0	1.00	Referent
		No	34	35.3	1.13 (0.62-2.08)	0.70
		Yes	144	41.7	1.43 (1.02-2.00)	0.04
	Q32. Returned to Normal Physical Activity Since Upper Limb Injury	No Injury	247	30.8	1.00	Referent
		No	11	72.7	2.93 (1.41-6.08)	<0.01
		Yes	168	38.7	1.31 (0.94-1.83)	0.11
Pain Limiting Activity	Q33. Have Foot Pain Limiting Activity at Times	No	363	32.5	1.00	Referent
		Yes	63	49.2	1.64 (1.10-2.44)	0.01
	Q34. Have Knee Pain Limiting Activity at Times	No	313	31.3	1.00	Referent
		Yes	113	45.1	1.67 (1.19-2.34)	<0.01
	Q35. Have Back Pain Limiting Activity at Times	No	341	32.8	1.00	Referent
		Yes	85	43.5	1.33 (0.92-1.93)	0.13

(8) Table 40 shows the univariate associations between injuries and tobacco use, physical activity, self-assessed fitness, prior injury, pain limiting activity, and menstrual history in the female new agents. Few of the questionnaire variables were significantly associated with injury among the women, presumably because of the small sample size. However, some of the trends followed those of the men. Although only three female new agents reported that they were less physically active than their peers, injury risk was elevated in these less active women, compared with the more active. Longer exercise durations tended to be associated with higher injury risk, especially for those performing weight training for longer periods. Although only five female new agents self-rated their endurance as less than average, injury risk tended to be elevated in this group compared with those who rated their endurance as greater than average. Foot, knee, or back pain that limited activity tended to be associated with elevated injury risk, and this was statistically significant for back pain. In contrast to the men, prior upper or lower limb injury had little association with injury risk in new agent training.

Table 40. Univariate Associations between Injury Risk and Questionnaire Variables among Female New Agents

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Tobacco Use	Q9. Smoked 100 Cigarettes in Lifetime	No	90	41.1	1.00	Referent
		Yes	15	46.7	1.17 (0.52-2.61)	0.71
	Q10. Age Smoked First Cigarette	Never Smoked	64	35.9	1.00	Referent
		6-17 years	23	52.2	1.65 (0.82-3.32)	0.16
		≥18 years	18	50.0	1.39 (0.65-3.01)	0.40
	Q11. Days smoked in Last 30 Days	Nonsmoker	102	42.2	1.00	Referent
		Smoked	3	33.3	0.69 (0.09-4.97)	0.71
	Q12. Cigarettes per Day in Last 30 Days	Nonsmoker	102	42.2	1.00	Referent
		Smoked	3	33.3	0.69 (0.09-4.97)	0.71
	Q13. If Quit Smoking, How Long Ago	Never Smoked	87	42.5	1.00	Referent
		Smoker	3	33.3	0.68 (0.09-4.94)	0.70
		Quit 1-24 Months Ago	2	0.0	-----	-----
		Quit ≥24 Months Ago	13	46.2	1.12 (0.47-2.66)	0.79
	Q14. Time Smoking	Nonsmoker	102	42.2	1.00	Referent
		Smoker	3	33.3	0.69 (0.09-4.97)	0.71
	Q15. Smokeless Tobacco Use Last 30 Days	Nonusers	104	42.3	1.00	Referent
		Users	1	0.0	-----	-----
	Q16. Amount of Smokeless Tobacco Last 30 Days	Nonusers	104	42.3	1.00	Referent
		Users	1	0.0	-----	-----
	Q17. If Quit Using Smokeless Tobacco, How Long Ago	Never Used	102	42.7	1.00	Referent
		Users	1	0.0	-----	-----
		Quit 1-24 Months	1	0.0	-----	-----
		Quit ≥24 Months Ago	1	0.0	-----	-----
	Q18. Time Using Smokeless Tobacco	Users	104	42.3	1.00	Referent
		NonUsers	1	0.0	-----	-----
Physical Activity	Q19. Self Rating of Physical Activity	Less Active	3	66.7	2.18 (0.53-9.06)	0.28
		About the Same	12	33.3	0.69 (0.25-1.94)	0.48
		More Active	90	42.2	1.00	Referent
	Q20. Frequency of Aerobic Exercise in Last 2 Months	≤ 1 time/week	0	---	-----	-----
		2-4 times/week	56	44.6	1.14 (0.63-2.07)	0.67
		≥5 times/week	49	38.8	1.00	Referent
	Q21. Duration of Aerobic Exercise Last 2 Months	0-30 minutes	9	44.4	0.89 (0.29-2.70)	0.83
		31-60 minutes	68	38.2	0.77 (0.40-1.45)	0.40
		≥61 minutes	28	50.0	1.00	Referent
	Q22. Frequency of Weight Training in Last 2 Months	≤ 1 time/week	24	41.7	0.90 (0.25-3.28)	0.88
		2-4 times/week	74	41.9	0.88 (0.27-2.89)	0.84
		≥5 times/week	7	42.9	1.00	Referent
	Q23. Duration of Weight Training in Last 2 Months	0-30 minutes	42	40.5	0.46 (0.19-1.10)	0.08
		31-60 minutes	53	37.7	0.38 (0.16-0.90)	0.03
		≥61 minutes	10	70.0	1.00	Referent
	Q24. Frequency of Playing Sports Last 2 Months	≤ 1 time/week	91	40.7	0.76 (0.34-1.71)	0.51
		2-4 times/week	14	50.0	1.00	Referent
		≥5 times/week	0	---	-----	-----
	Q25. Duration of Sports in Last 30 Days	0-30 minutes	59	42.4	0.85 (0.37-1.97)	0.71
		31-60 minutes	32	37.5	0.71 (0.28-1.80)	0.48
		≥61 minutes	14	50.0	1.00	Referent

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Fitness	Q26a. Self Rating of Endurance	Less Than Average	5	60.0	1.87 (0.57-6.13)	0.30
		Average	24	41.7	1.12 (0.55-2.30)	0.75
		Greater Than Average	75	40.0	1.00	Referent
	Q26b. Self Rating of Sprint Speed	Less Than Average	7	57.1	1.96 (0.68-5.67)	0.22
		Average	45	37.8	0.81 (0.44-1.52)	0.52
		Greater Than Average	53	43.4	1.00	Referent
	Q26c. Self Rating of Strength	Less Than Average	8	50.0	1.36 (0.47-3.96)	0.57
		Average	38	44.7	1.18 (0.63-2.23)	0.61
		Greater Than Average	58	37.9	1.00	Referent
	Q26d. Self Rating of Flexibility	Less Than Average	16	31.3	0.63 (0.24-1.69)	0.36
		Average	44	45.5	1.16 (0.62-2.18)	0.64
		Greater Than Average	45	42.2	1.00	Referent
	Q26e. Self Rating of Push-Up Performance	Less Than Average	12	41.7	0.94 (0.36-2.45)	0.90
		Average	35	40.0	0.84 (0.43-1.61)	0.59
		Greater Than Average	58	43.1	1.00	Referent
	Q26f. Self Rating of Sit-Up Performance	Less Than Average	5	40.0	0.98 (0.23-4.10)	0.97
		Average	36	41.7	0.95 (0.50-1.78)	0.95
		Greater Than Average	64	42.2	1.00	Referent
	Q26g. Self Rating of Body Fat	Less Than Average	34	32.4	1.00	Referent
		Average	54	46.3	1.69 (0.83-3.44)	0.15
		Greater Than Average	17	47.1	1.42 (0.57-3.52)	0.45
Prior Injury	Q27. Injured Lower Limb	No	40	42.5	1.00	Referent
		Yes	65	41.5	1.07 (0.59-1.97)	0.82
	Q28. Lower Limb Injury Prevented Normal Physical Activity for ≥ 1 Week	No Injury	40	42.5	1.00	Referent
		No	10	30.0	0.73 (0.22-2.50)	0.62
		Yes	55	43.6	1.14 (0.61-2.12)	0.68
	Q29. Returned to Normal Physical Activity Since Lower Limb Injury	No Injury	40	42.5	1.00	Referent
		No	4	50.0	1.29 (0.30-5.61)	0.73
		Yes	61	41.0	1.06 (0.57-1.96)	0.86
	Q30. Injured Upper Limb	No	73	41.1	1.00	Referent
		Yes	32	43.8	1.04 (0.55-1.97)	0.90
	Q31. Upper Limb Injury Prevented Normal Physical Activity for ≥1 Week	No Injury	73	41.1	1.00	Referent
		No	9	33.3	0.88 (0.27-2.88)	0.83
		Yes	23	47.8	1.10 (0.55-2.20)	0.79
	Q32. Returned to Normal Physical Activity Since Upper Limb Injury	No Injury	73	41.1	1.09 (0.58-2.05)	0.97
		No	1	0.0	-----	-----
		Yes	31	45.2	1.00	Referent
Pain Limiting Activity	Q33. Have Foot Pain Limiting Activity at Times	No	81	39.5	1.00	Referent
		Yes	24	50.0	1.46 (0.75-2.84)	0.27
	Q34. Have Knee Pain Limiting Activity at Times	No	82	41.5	1.00	Referent
		Yes	23	43.5	1.24 (0.61-2.51)	0.55
	Q35. Have Back Pain Limiting Activity at Times	No	84	35.7	1.00	Referent
		Yes	21	66.7	2.33 (1.23-4.40)	<0.01

Variable Category	Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Menstrual History	Q36. Age of Menarche	8-11 Years	9	22.2	0.43 (0.10-1.77)	0.24
		12-14 Years	76	46.1	1.00	Referent
		≥15 Years	19	31.6	0.61 (0.26-1.45)	0.26
	Q37. Menstrual Periods Last Year	1-10	20	40.0	0.85 (0.40-1.84)	0.69
		11-13	84	41.7	1.00	Referent
	Q38. Gone ≥ 6 Months without Menstrual Cycle	No	102	40.2	1.00	Referent
		Yes	2	100.0	2.84 (0.69-11.77)	0.15
	Q39. Used Birth Control in Past 12 Months	No	47	48.9	1.52 (0.84-2.77)	0.17
		Yes	57	35.1	1.00	Referent
	Q40. Used Hormonal Therapy in Past 12 Months	No	97	41.2	0.88 (0.27-2.85)	0.83
		Yes	7	42.9	1.00	Referent
	Q41. Ever Pregnancy	No	90	40.0	1.00	Referent
		Yes	12	41.7	1.02 (0.40-2.61)	0.96

(9) Table 41 shows the univariate associations between demographic variables and injury risk in new agent men. Injury risk was associated with having children but none of the other demographic variables.

Table 41. Univariate Associations between Injury Risk and Demographic Variables among Male New Agents

Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Race	White	343	34.4	1.00	Referent
	Hispanic	25	36.0	1.03 (0.52-2.02)	0.94
	Asian	13	46.2	1.34 (0.59-3.05)	0.48
	Black	13	30.8	0.81 (0.33-2.40)	0.81
	American Indian	1	0.0	-----	-----
Married	No	145	31.0	1.00	Referent
	Yes	276	36.2	1.22 (0.86-1.74)	0.26
Children	None	241	31.1	1.00	Referent
	1 or More	184	39.3	1.40 (1.01-1.93)	0.04
Entry Program	Accounting/Finance	48	35.4	1.00	Referent
	Information Technology	32	31.3	0.89 (0.41-1.94)	0.77
	Diversified	130	36.9	1.02 (0.59-1.77)	0.95
	Engineering/Science	33	30.3	0.82 (0.37-1.80)	0.63
	Intelligence	30	36.7	1.01 (0.47-2.16)	0.97
	Language	26	38.5	1.04 (0.48-2.27)	0.92
	Law	28	35.7	0.95 (0.44-2.08)	0.91
	Law Enforcement/Military	51	23.5	0.57 (0.27-1.20)	0.14
	Tactical	15	40.0	1.16 (0.46-2.94)	0.75
	TRP	19	36.8	1.02 (0.42-2.46)	0.97
Educational Level	Bachelor Degree	254	31.5	1.00	Referent
	Master's or Doctoral Degree	170	39.4	1.09 (0.79-1.51)	0.70
Foreign Language	No	291	32.2	1.00	Referent
	Yes	133	39.8	1.29 (0.92-1.80)	0.14
Military Experience	No	248	35.5	1.00	Referent
	Yes	176	33.5	0.92 (0.66-1.27)	0.60
Law Enforcement Experience	No	326	35.3	1.00	Referent
	Yes	98	32.7	0.84 (0.57-1.25)	0.39
Dominate Hand	Right	387	43.1	1.00	Referent
	Left	33	39.4	1.23 (0.69-2.17)	0.48
	Ambidextrous	2	50.0	1.58 (0.22-11.32)	0.65

(10) Table 42 shows the univariate associations between demographic variables and injury risk in female new agents. Higher injury risk was associated with Hispanic race, lack of military experience, and being left-handed.

Table 42. Univariate Associations between Injury Risk and Demographic Variables among Female New Agents

Variable	Level of Variable	N	Injured (%)	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Race	White	76	34.2	1.00	Referent
	Hispanic	9	88.9	3.29 (1.47-7.34)	<0.01
	Asian	6	50.0	2.12 (0.64-7.00)	0.22
	Black	5	20.0	0.52 (0.07-3.77)	0.51
Married	No	67	44.8	1.00	Referent
	Yes	35	37.1	0.79 (0.41-1.51)	0.47
Children	None	91	44.0	1.00	Referent
	1 or More	13	30.8	0.63 (0.23-1.77)	0.38
Entry Program	Accounting/Finance	11	54.5	1.00	Referent
	Information Technology	4	25.0	0.29 (0.03-2.38)	0.25
	Diversified	34	41.2	0.61 (0.23-1.59)	0.31
	Engineering/Science	12	66.7	1.44 (0.50-4.16)	0.50
	Intelligence	11	36.4	0.57 (0.16-2.00)	0.38
	Language	8	37.5	0.48 (0.12-1.91)	0.30
	Law	16	43.8	0.64 (0.22-1.91)	0.42
	Law Enforcement/Military	3	33.3	0.49 (0.06-4.07)	0.51
Educational Level	Bachelor Degree	44	43.2	1.00	Referent
	Master's or Doctoral Degree	60	41.7	0.96 (0.53-1.75)	0.90
Foreign Language	No	56	41.1	1.00	Referent
	Yes	48	43.8	1.09 (0.60-1.97)	0.78
Military Experience	No	86	46.5	1.00	Referent
	Yes	18	22.2	0.41 (0.15-1.14)	0.09
Law Enforcement Experience	No	84	45.2	1.00	Referent
	Yes	20	30.0	0.59 (0.25-1.41)	0.24
Dominate Hand	Right	93	39.8	1.00	Referent
	Left	5	80.0	2.73 (0.97-7.68)	0.06
	Ambidextrous	1	100.0	----	-----

g. Multivariate Analysis of Injury Risk Factors.

(1) Table 43 shows the results of the multivariate backward stepping Cox regression examining associations between any injury and potential risk factors among the men. Independent risk factors for injuries included older age, slower sprint speed, slower 1.5-mile run time, having not smoked 100 cigarettes in a lifetime, less active self-rating of physical activity relative to peers, lower and higher frequency of aerobic training, having a prior upper limb injury, having a prior upper limb that did not allow returning to normal physical activity, and having knee pain that limits physical activity.

Table 43. Multivariate Analysis of Potential Injury Risk Factors in New Agent Men

Variable	Level of Variable	N	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
Age	24-30 years	187	1.00	Referent
	30-37 years	238	1.70 (1.20-2.42)	<0.01
300-Meter Sprint	40-44 seconds	122	1.00	Referent
	44-46 seconds	132	1.34 (0.84-2.16)	0.22
	47-48 seconds	108	1.84 (1.31-3.00)	0.01
	49-55 seconds	63	1.75 (1.01-3.02)	0.05
1.5-Mile Run	8.18-10.35 minutes	108	1.00	Referent
	10.36-11.10 minutes	107	1.14 (0.67-1.94)	0.63
	11.11-11.64 minutes	104	1.84 (1.11-3.04)	0.02
	11.65-15.02 minutes	106	1.95 (1.19-3.20)	<0.01
Q9. Smoked 100 Cigarettes in Lifetime	No	351	1.00	Referent
	Yes	74	0.42 (0.25-0.71)	<0.01
Q19. Self Rating of Physical Activity	Less Active	6	6.68 (2.52-17.70)	<0.01
	About the Same	30	0.56 (0.27-1.17)	0.12
	More Active	389	1.00	Referent
Q20. Frequency of Aerobic Exercise in Last 2 Months	≤ 1 time/week	2	4.58 (0.97-21.71)	0.06
	2-4 times/week	263	0.69 (0.49-0.97)	0.03
	≥5 times/week	160	1.00	Referent
Q32. Returned to Normal Physical Activity Since Upper Limb Injury	No Injury	246	1.00	Referent
	No	11	3.36 (1.48-7.62)	<0.01
	Yes	168	1.41 (1.00-2.00)	0.05
Q34. Have Knee Pain Limiting Activity Sometime	No	313	1.00	Referent
	Yes	112	1.84 (1.28-2.64)	<0.01

(2) Table 44 shows the results of the multivariate backward stepping Cox regression examining associations between any injury and the potential risk factors among the women. Independent risk factors for injuries included slower 1.5-mile run time, reporting back pain that limited physical activity, and left handedness.

Table 44. Multivariate Analysis of Potential Injury Risk Factors in New Agent Women

Variable	Level of Variable	N	Hazard Ratios (95%CI) from Cox Regressions	p-value (from Wald statistic)
1.5-Mile Run	10.05-12.06 minutes	34	1.00	Referent
	12.07-12.95 minutes	32	1.00 (0.46-2.18)	0.99
	12.96-14.92 minutes	32	1.95 (0.97-3.93)	0.06
Q35. Have Back Pain Limiting Activity Sometime	No	78	1.00	Referent
	Yes	20	2.37 (1.27-4.43)	<0.01
Dominate Hand	Right	93	1.00	Referent
	Left	5	2.52 (0.89-7.15)	0.08

7. DISCUSSION. The present project complements the earlier retrospective investigation[1] of injuries and physical fitness among FBI new agents by prospectively examining injury rates and also examining a greater number of potential injury risk factors. In the previous investigation,[1] the only risk factor examined was physical fitness. In addition to physical fitness, the present investigation also examined age, height, weight, BMI, tobacco use, prior physical activity, self-assessed fitness, prior injury, menstrual history, and demographic variables. Compared to the retrospective investigation, the present investigation included a much smaller number of new agents which limited statistical power, especially among women. Despite this, a number of additional injury risk factors were identified and these offer further suggestions for injury prevention in new agent training. Before these risk factors are discussed, similarities and differences in the injury and fitness data in the retrospective[1] and prospective investigations are considered, along with a comparison of injury rates among new agent and military trainees.

a. Comparison of Injury Data in Retrospective and Prospective Investigations.

(1) The previous retrospective investigation[1] reported an overall injury incidence (any injury) of 40% for men and 45% for women for training during the FY03 through FY08 period. In the present investigation, the overall injury incidence was slightly lower, 35% for men and 42% for women. Figure 1, which shows injury incidence over the FYs, shows that the injury incidence in the current investigation is within the range of the yearly injury rates seen in the past. The reason for the lower injury incidence in FY 08 is not clear. Nonetheless, the present cohort appears to be representative with regard to the overall incidence of injury.

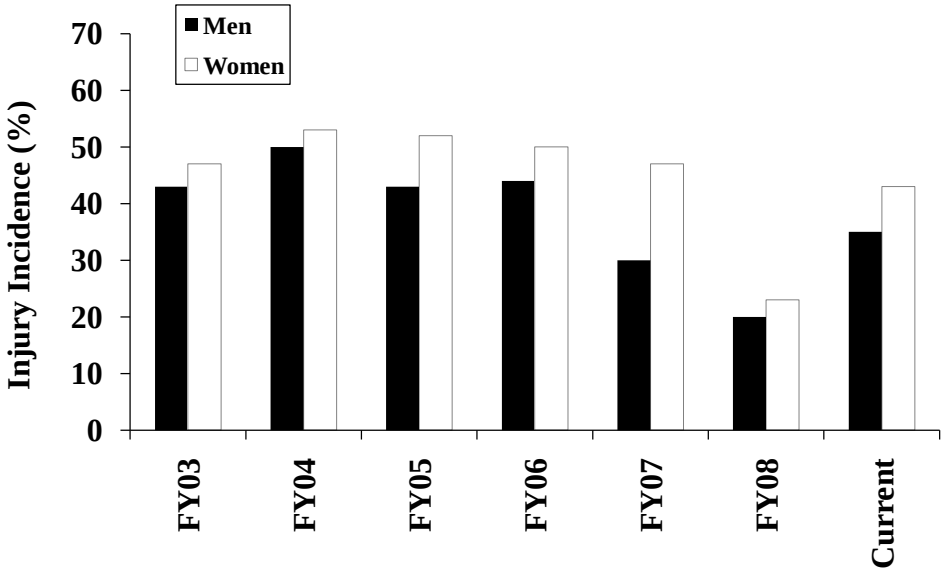

Figure 1. Incidence of Any Injury from Retrospective Data (FY03 to FY08) and Current Prospective Data

(2) The present prospective investigation improved on the retrospective investigation by accounting for time at risk. The retrospective analysis assumed that all agents completed the training course, but obviously some new agent trainees did not. Analyses in the retrospective investigation suggested that the error induced by the drop-outs was small since only 3-4% of new agents permanently dropped out of the course. The present investigation had a similar drop out incidence since conversions, dismissals, and resignations accounted for 4% (n=22) of the initial cohort (some of the recycle-outs may have permanently dropped out of the course later but we did not track these). Nonetheless, the present prospective study provides a more accurate estimate of injury risk in the time period examined.

(3) We found more specific diagnoses in the medical records in the present prospective investigation compared with the previous retrospective investigation.[1] For example, in the retrospective investigation, traumatic musculoskeletal pain (not otherwise specified) accounted for 27% of the diagnoses while in the present study this category was only 12% of the diagnosis. The traumatic musculoskeletal pain category involved encounters where an individual reported pain in a specific musculoskeletal location but no specific diagnosis was found in the medical record. The higher diagnostic specificity in the prospective study was likely due to the presence of a full-time, on-site physician who was at the FBI Health Clinic for the entire investigation and

performed many of the diagnoses. In the retrospective investigation, a physician was on-site for only a small time. Table 45 compares the most common injury diagnoses in the retrospective and prospective investigations.

Table 45. Comparison of Most Common Diagnosis in Retrospective and Prospective Investigations

	Retrospective Investigation, FY00-08 (% of all injuries)	Prospective Investigation (% of all injuries)
Joint Injury (traumatic)	10	14
Muscle Injury (traumatic)	11	12
Musculoskeletal Pain (traumatic)	27	12
Abrasions/Lacerations	9	11
Contusions	9	11
Total Accounted For	66	60

(4) In the present prospective study, the largest number of specific diagnoses (i.e., exclusive of musculoskeletal pain) was for strains, sprains, contusions, and abrasions/lacerations. These are common injuries in physically active groups of individuals who are involved in running, sports, recreational activities, and military training.[12, 13, 170-178] In the prospective study, there were few cases of more serious traumatic injuries such as bone fractures, dislocations, and subluxations; these totaled only 4% of all injuries. In studies of runners and collegiate sports athletes, fractures, subluxations, and dislocations have accounted for 3% to 13% of all injuries.[170, 172, 173, 175-178] Less serious traumatic injuries like abrasions/lacerations accounted for 11% of all injuries and contusions accounted for 11% also. This is comparable to finding in the sports literature in which abrasions and lacerations accounted for 8% to 11% of all injuries,[173, 176, 178] and contusions accounted for 6% to 24% of all injuries.[172, 175, 177, 178] With regard to specific overuse injuries, tendonitis accounted for less than 2% to 3% of FBI new agent injuries but in runners, college athletes, and military trainees this injury accounts for 5% to 12% of all injuries.[13, 170-172, 174, 176] It appears that more serious injuries are less common in FBI new agent training than the incidence seen in other groups of active individuals.

(5) Among new agent trainees in the prospective investigation, only 14% of injuries were classified as overuse, with 68% classified as traumatic. This was similar to the retrospective investigation[1] which found 15% and 70% of injuries were classified as overuse and traumatic, respectively. In contrast to this finding, in military basic training overuse-type injuries account for about 75% of all injuries.[16] This difference might be accounted for by contrasting the patterns of activity in these two types of training. In US Army Basic Combat Training (BCT), recruits perform virtually all physical training as a group regardless of fitness level. During running activities, individuals of similar fitness run together[179] but with this one exception, all other physical and operational training is conducted together, regardless of fitness level. The basic rationale is to keep the recruits together to build fitness and operational competence while at the same time developing morale (esprit de corps) and teamwork, all under the guidance of a

knowledgeable leader, the drill sergeant. In contrast, FBI new agent trainees perform most of their physical fitness training on their own. There are 91 hours (out of 850 hours) of physical training, but most of this is in defensive tactics with only about 11 hours involving group physical fitness training which includes the PFT. It is likely that the individualized physical training performed by FBI new agents resulted in fewer overuse injuries since the intensity, frequency, and duration is determined by the individual agent. For example, an agent should voluntarily skip a training day or reduce the amount of exercise if the individual was feeling pain or other symptoms that might suggest that might suggest impending injury. Further, defensive tactics training, comprising much of group physical training, involved activities like boxing, subduing suspects (wrestling, grappling, handcuffing), and defensive movements which likely leading to a higher incidence of traumatic injuries. In fact, over half of the injuries in FBI new agent training occurred in association with defensive tactics and only about 20% to 25% in other physical training.

(6) Because of the potential consequences and past history at the FBI Academy, there was high interest among the FBI Academy leadership in rhabdomyolysis. No cases were diagnosed during the current prospective project. In the retrospective project,[1] the overall number of new cases was 14 among 4767 new agents for an incidence of 2.9 cases/1,000 new agents. Thus, only 1 or 2 cases might have been expected among the 531 new agents who participated in the prospective project. In the retrospective investigation, no cases of rhabdomyolysis were found in 4 of the 9 FYs examined and most cases (8 of 14) occurred in a single FY, FY08. Further, physical trainers and the medical staff were well aware of the high number of cases in FY08 and may have taken steps to minimize the possibility of more cases. Nonetheless, physical trainers and the medical staff should be advised to remain vigilant for signs and symptoms of rhabdomyolysis, as defined in the Background section of this paper. Medical staff should be prepared to rapidly treat cases, as outlined in the Background section.

(7) Table 46 compares the proportion of injuries occurring in various anatomical locations in the retrospective and prospective investigations. With regard to general body areas, the prospective investigation had a slightly higher proportion of head injuries compared with the retrospective investigation.[1] At specific anatomical locations, the proportion of injuries in the retrospective and prospective investigations was similar for all areas except the head and fingers (the head area excludes the face, ears and eyes which are counted separately).

Table 46. Comparison of Anatomic Locations in Retrospective and Prospective Investigations

Anatomical Areas		Retrospective Investigation, FY00-08 (% of all injuries)	Prospective Investigation (% of all injuries)
General Areas	Head	16	20
	Upper Body	42	43
	Lower Body	37	32
	Unknown/Other/Multiple	5	5
Specific Areas	Knee	10	10
	Shoulder	8	8
	Face	7	6
	Eyes	7	8
	Ankle	6	5
	Chest	4	4
	Fingers	3	7
	Head	2	5

(8) The incidence of closed head injuries/concussions was much higher in the prospective investigation compared with the retrospective investigation. In the prospective investigation there were 11 cases out of 534 new agents for an incidence of 2.1%. In the retrospective investigation there were 19 cases among 4,767 new agents for an incidence of 0.4%. The risk ratio (prospective/retrospective) was thus 5.17, 95% CI=2.47-10.80. As a proportion of all injuries, close head injuries/concussions accounted for 11% and 0.4% of all injuries in the prospective and retrospective investigations, respectively. In 8 of the 11 (73%) prospective closed head injury/concussion cases, bull-in-the-ring the activity listed in association with the injury. In the other 3 prospective cases (27%), boxing was the activity listed (it was not clear whether this meant boxing alone or as part of bull-in-the-ring). In conversations with the on-site physician and the Physical Training Unit staff it was found that stricter criteria were being used to define concussion/closed head injury during the prospective study. The criteria were from the Brain Trauma Foundation (www.braintrauma.org <http://www.braintrauma.org/>), although other sources were also consulted. Both the medical staff and Physical Training Unit were likely to remove new agents from activities (especially boxing) if the signs/symptoms were noted. Thus, the higher incidence was likely due to better awareness and improved surveillance.

(9) In the prospective investigation, 32% of injury cases involved the lower body and 43% involved the upper body, about the same as in the retrospective investigation, as shown in Table 46. In sports and recreational activities, the lower body is the site of over 50% of injuries and up to 84% of all injuries.[85, 173, 177, 180] In military basic training, 77% to 88% of injuries are to the lower body[13, 16] and in military infantry operational training about 50% to 60% of injuries involve the lower body.[181-183] Much of military training involves the lower body in activities like sprinting, running, patrols on foot while carrying equipment, walks to training area, drill and ceremony, and the like. Much of FBI new agent training in defensive tactics training involves the upper body in boxing and suspect apprehension (handcuffing, subduing, wrestling). In a

study of active law enforcement officers combined with police trainees,[4] the major injury sites were hand/wrist (23%), back (16%), and knee (10%). This compares with 14%, 6%, and 10%, respectively, in the present study.

(10) Figure 2 compares the proportion of injuries associated with defensive tactics, physical fitness training and physical fitness testing in the retrospective and prospective investigations. In both investigations these were the three leading activities associated with injury. The proportion of injuries associated with physical fitness training has declined over the years while that associated with defensive tactics increased from FY00 to FY05 and has plateaued since FY05. The current prospective investigation has the highest proportion of injuries due to defensive tactics in the past FYs.

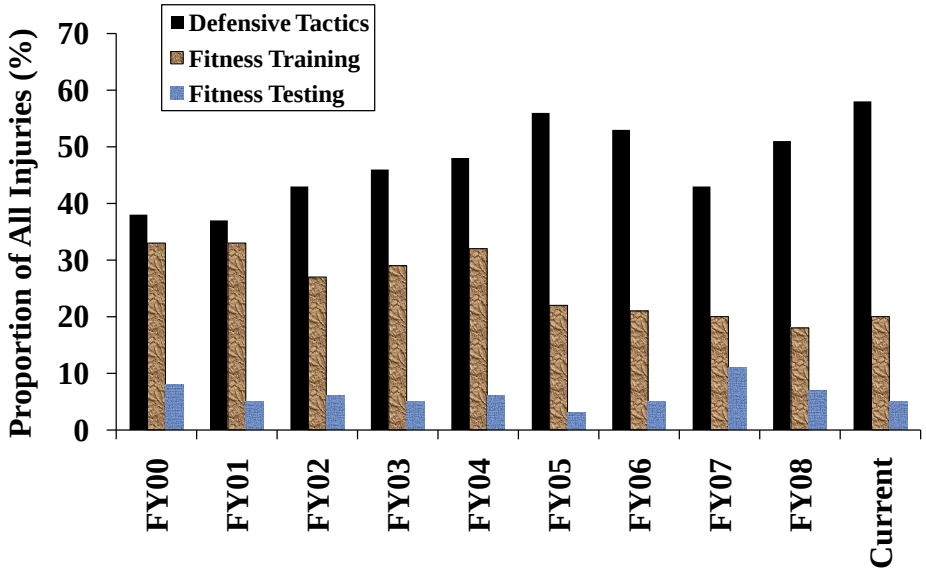

Figure 2. Proportion of New Agent Injuries Associated with Defensive Tactics Training, Physical Fitness Training, and Physical Fitness Testing from the Retrospective Data and Current Prospective Investigation

(11) From an injury-prevention standpoint, the most important information in the medical records is the activity associated with the injury. In some cases, the injury will be of the overuse type and have an insidious onset making it difficult to link to a specific event. In both the retrospective[1] and prospective projects we could often link the injuries to a specific training activity, but the recording of activities associated with injury was not standardized in the medical records so any accounting of activities associated with the injury was incomplete. For example,

although we could estimate that about 60% of the prospective injuries were associated with defensive tactics, often the medical records provided no further information. On other occasions the record might list "bull-in-the-ring" and, since we knew this was part of defensive tactics training, we could include it there. However, many times just "defensive tactics" was listed with no further information.

(12) To improve collection of information on injury mechanisms, information should be obtained on both the activity associated with the injury and the mechanism of injury. Mechanism notes should include exactly how the injury occurred. An example is a simple note like "another student fell on patient's outstretched arm during grappling in defensive tactics". This includes both the training activity (defensive tactics, grappling) and the mechanism of injury (body fell on arm).

(13) Given the emphasis in the curriculum and the physical involvement, it is reasonable that most of the injuries would occur during defensive tactics and physical training. We observed that many safety features were in place at the FBI academy during defensive tactics training and the staff was knowledgeable in this area. Examples in boxing are the use of boxing gloves, headgear, and mouthpieces. During other defensive tactics training, new agents were provided practice on cushioned mats, which offered some protection during falls and takedowns. Nonetheless, defensive tactics should be further examined to determine whether additional safety measures can be put in place.

(14) Table 47 compares the proportion of dispositions in the retrospective and prospective investigations. In the prospective investigation, a smaller proportion of new agents was referred for consults. This is likely due to the presence of an on-site physician who could perform diagnosis and provide or delegate appropriate treatment.

Table 47. Comparison of Dispositions in Retrospective and Prospective Investigations

	Retrospective Investigation, FY00-08 (% of all injuries)	Prospective Investigation (% of all injuries)
Return To Duty	42	67
Limited Duty	7	8
Consults	50	21
Other/Unknown	1	4

(15) We found that in 9% of the new injury cases, injury-related data were only available from the CA-1s. For these cases, no encounters were listed in the medical database, only on the CA-1s. These may have been injury cases that occurred after hours or on the weekend when the clinic was closed; the new agent had to seek medical care elsewhere. Also, these may have been emergency cases where an emergency medical technician was called in and no record was made in the clinic.

b. Comparisons of FBI and Military Injury Incidence.

(1) Comparisons of overall injury incidence between FBI new agent trainees with other physically active groups are complicated by the different time periods over which the injury data were collected (i.e., different time-at-risk for injuries). One might assume that adjustment for time at risk by equating time periods would account for this. For example, FBI injury incidence might be adjusted to a monthly rate by dividing the injury incidence by 5.25 (21 weeks are 5.25 months). However, this assumes that injuries are equally distributed across the training period. This is not the case for FBI new agent training, as there are more injuries earlier in training. For example, in this prospective study 45% of injury cases occurred during the first 6 weeks of training and 6 weeks is about 30% of the total training period. Thus, comparisons of monthly injury incidence rate in groups with longer training times (i.e., FBI new agent training) will tend to underestimate the monthly injury incidence rate when compared to groups with shorter training periods (e.g., military basic training).

(2) A more appropriate comparison may be to look at cumulative injury incidence in comparable time periods. Thus, injury incidences were calculated for the first 6, first 9, and first 12 weeks of FBI new agent training in both the retrospective and prospective investigations. This allowed comparisons with injury incidence in Air Force, Army and Marine Corps basic training which were 6, 9, and 12 weeks, respectively (from Table 1). Table 48 shows these calculations and comparisons. It can be seen that injury incidences among male new agent trainees is generally slightly lower or within the lower range of men in basic military training. On the other hand, women in new agent training have a much lower injury incidence than women in basic military training. The lower injury rate may be related to the higher fitness level of the female FBI new agent trainees (compared with military women) as discussed below.

Table 48. FBI New Agent Training Injury Incidence Compared with the Basic Military Training at the Same Time Intervals

		FBI New Agent Training Injury Incidence (%)			Range of Air Force Injury Incidence (%) (6 weeks of training)	Range of Army Injury Incidence (%) (9 weeks of training)	Range of Marine Corps Injury Incidence (%) (12 weeks of training)
		6 Weeks	9 Weeks	12 Weeks			
Men	Retrospective Investigation	17	23	29	17-28	14-37	25-60
	Prospective Investigation	15	18	23			
Women	Retrospective Investigation	26	31	36	38-47	36-65	41-53
	Prospective Investigation	24	30	33			

c. FBI New Agent Fitness Compared with Other Groups.

(1) Table 49 shows PFT values in the prospective investigation and compares FBI new agent trainees with groups of military basic trainees and other law enforcement officers. Only test events that were conducted in a manner identical to the FBI PFT events are included in the table. No comparable data were available on the 300-meter sprint. Average pull up performance of the male FBI new agent trainees was identical to that of Marine recruits[30] and Canadian policemen[50] and higher than that of Louisville police recruits[45] and Finnish police.[51] Average pull-up performance of the female FBI new agent trainees was identical to female Canadian police.[50] Average push-up and sit-up performance of male FBI new agent trainees was slightly lower than that of Canadian police recruits and Canadian College students[52] but higher than that of longer-serving Canadian police[50] and North Carolina law enforcement trainees.[47] Average push-up performance of female FBI new agent trainees was lower than that of female Canadian police recruits[52]. Average sit-up performance of female FBI new agent trainees was higher than that of female Canadian police or police recruits[52] and also higher than North Carolina law enforcement trainees.[47] Average time of male FBI recruits on the 1.5-mile run was faster than that of Marine Corps recruits,[30] Air Force recruits,[23] and Canadian police recruits/college students.[52] Performance on the 1.5-mile run was much higher for female new agents that for female Marine Corps recruits,[30] Air Force recruits,[23] or Canadian police recruits/college students.[52] On the whole, the PFT performance of FBI new agents was similar to or higher than that of other military and law enforcement groups. Running performance of female FBI new agent trainees was especially fast, relative to other groups.

Table 49. Comparison of Fitness Measures of FBI New Agent Compared with Military Basic Trainees and Other Law Enforcement Groups

Group	Gender (n)	Pull-Ups (repetitions)	Push-ups (repetitions)	Sit-Ups (repetitions)	1.5-mile Run (min)
FBI New Agent Trainees (Prospective Investigation)	Men (n=426)	8±4	37±9	44±5	11.1±1.0
	Women (n=105)	1±2	17±9	42±7	12.5±1.2
Marine Recruits[30]	Men (n=782)	8±5	ND	ND	11.3±1.1
	Women (n=568)	ND	ND	ND	13.8±1.2
Air Force Recruits[23]	Men (n=1,713)	ND	ND	ND	12.9±1.8
	Women (n=682)	ND	ND	ND	16.7±2.7
Canadian Police[50]	Men (n=78)	8±4	29±12	33±8	ND
	Women (n=27)	1±2	ND	38±9	ND
Canadian Police Recruits & College Students[52]	Men (n=21)	ND	39±14	47±10	11.4±2.1
	Women (n=27)	ND	21±11	43±13	13.3±3.0
Louisville Police Trainees[45]	Men (n=54)	5±3	ND	ND	ND
North Carolina Law Enforcement Trainees[47]	Men (n=136)	ND	ND	38±9	ND
	Women (n=33)	ND	ND	31±7	ND
Finnish Police[51]	Men (n=90)	5±3	ND	ND	ND

ND=No Data reported

(2) Aerobic capacity (VO_2max) of new FBI recruits can be estimated from 1.5-mile run times by using available equations. VO_2max is the criterion measure for aerobic capacity. It is the highest rate at which oxygen can be taken up and used by the body during longer-term exercise[184] like running. The faster the rate at which oxygen can be used, the faster the rate at which energy can be produced and the higher the rate at which longer-term physical activity (like running) can be performed.

(3) Five equations for predicting VO_2max from 1.5-mile run times are presented in Table 50 along with some descriptive information on the subjects used to develop the equations. The subjects used by Pollock and Wilmore[185] are not clear. They only presented 1.5-mile run with matched VO_2max data and those data were used by the present authors to develop the equation. All other studies obtained actual VO_2max using a graded running treadmill test with expired gas measurement, then had the same individuals complete a maximal effort 1.5-mile run. Equations were established using linear regression. Only two equations[185, 186] could be applied to the retrospective FBI new agent data[1] because some equations[187, 188] required body weight, which was not available in the retrospective investigation.[1] An additional equation[187] could be applied to the prospective investigation because body weight was available here. One equation[189] was incorrectly printed in the article and another[188] required heart rate during running (and the regression coefficient for the heart rate factor was not provided in the article). Table 51 provides predicted VO_2max values from the predictive equations. The VO_2max estimates were close, differing by no more than 3% in either the retrospective[1] or prospective investigations.

Table 50. Studies Proving Equations for Estimating VO_2max from 1.5-Mile Run Time

Study (Reference Number)	Subject data			Measured VO_2max (ml/kg/min)	Correlation Coefficient Between Run Time &VO_2max	Equation for Predicting VO_2max
	N, Subject Description	Height (cm)	Weight (kg)			
Larsen et al. 2002[187]	57 men, 55 women, American College Students, age 21±2 years	171±10[a]	72±16[a]	46±7	0.86	65.40+7.707(gender, 0=women, 1=man)-0.159 (body mass, kg)-0.843 (1.5-mile run time, min)
McNaughton et al. 1998[189]	32 men, Australian physical education college students, age 20 years	179±2	74±3	60±1	0.87	-45.851=(1.788 (1.5-mile run time, min)) (This is obviously incorrect, but what is in the article)
Pollock and Wilmore[185]	Not Provided	Not Provided	Not Provided	Not Provided	0.91	93.37-3.89 *(1.5-mile run time, min)[b]
Getchell et al. 1997[186]	21 female American college students, age 20±2 years	165±6	57±8	46±6	0.92	98.3-4.182 * (1.5 min run time, min)
George et al. 1993[188]	88 male and 61 female American college students, age 18-29 years.	Men: 178±10 Women: 173±10	Men: 74±8 Women: 60±6	Men: 52±5 Women: 43±**4**	0.90	88.02+3.716*(gender)-0.1656 * (body mass, kg)-2.767 *(1.5-mile run time, min)-coefficient (heart rate)

[a]Male and female data were combined
[b]Estimated from data provided in book

(4) Shvartz and Reibold[190] provided VO_2max norms based on a review of 62 studies which included individuals aged 6 to 75 years. Seven fitness divisions were established for different age groups based on mean and standard deviation (SD) values (±1-3 SDs, plus mean). In the prospective investigation, the estimated VO_2max of male new agent trainees (average age 31 years) placed them into Shvartz and Reibold's "good" (third highest of seven) category encompassing approximately the 68th to 89th percentile. The estimated VO_2max of male FBI new agent trainees (~51 ml/kg/min, Table 51) was the same as men entering the Army who had an average±SD VO_2max of 51±5 ml/kg/min.[191] In the prospective investigation, different VO_2max estimates (44-46 ml/kg/min, Table 51) placed female new agents (average age 30 years) in either Shvartz and Reibold's "good" (third highest) or "very good" (second highest) category encompassing approximately the 68th to 97th percentile. FBI new agent females had a higher estimated VO_2max (Table 51) compared with women entering the Army: the latter group had an average±SD VO_2max of 39±5 ml/kg/min.[191] New Army recruits are younger (average age 20 years) than FBI new agent trainees and VO_2max declines with age[190] suggesting that the relative

aerobic fitness of FBI new agents might be higher than Army recruits if adjusted for age. Further, the 1.5-mile run was administered as the third event of the PFT. It is possible that the fatigue accumulated from the previous tests (especially from the 300-meter run) might have affected the 1.5-mile run times; run times may be have been faster if the run test was administered in isolation.

Table 51. VO_2max of FBI New Agent Trainees Estimated from 1.5-Mile Run Times

Gender	Investigation	Predicted VO_2max (ml/kg/min)			Approximate Percentile Ranking Based on Normative VO_2max Data[190]
		Getchell et al. Equation[186]	Pollock and Wilmore Equation[185]	Larsen et al.[187]	
Men	Retrospective	51.0	49.4	[a]	68^{th}-89^{th}
	Prospective	51.9	50.2	50.7	
Women	Retrospective	45.2	43.9	[a]	68^{th}-97^{th}
	Prospective	46.0	44.7	45.1	

[a]Equation could not be applied to the retrospective data because body weight was not available

d. Injury Risk Factors.

(1) Age.

(a) In the prospective investigation, the age range was only 14 years, with the youngest individual 24 years of age and the oldest, 39 years. Nonetheless, when new agents were partitioned into those above and below 30 years of age, older male new agents were at higher injury risk and older female new agents tended to be higher risk. These data correspond to investigations in military basic training[12, 16, 43, 58] and airborne operations[192-194] which also shows that older individuals are at higher risk of injury. However, studies of infantry Soldiers [75, 183] and predominately infantry Soldiers[195] that have shown that younger men are at higher injury risk compared with older men. One possible explanation for the discrepancy between the new agent, basic training, airborne, and infantry data[183] might be that in the infantry, younger Soldiers may perform more of the arduous occupational tasks and thus be more susceptible to injury than older Soldiers, who are likely to be of higher rank and working in supervisory or staff positions. FBI new agent training, military basic training, and airborne training, differ from the operational infantry in that all individuals perform similar physical tasks. Under conditions where physical activity is similar, older individuals appear to be more susceptible to injury.

(b) The reason for the higher susceptibility to injury in older individuals may have to do with age-related changes in stem cells, declines in fitness, and/or prior injury history. First, consider changes in stem cells. Older tissues have less regenerative capability, due at least partially to age-related declines in the ability of resident stem cells to initiate and conduct tissue repair.[196-198] This could make older individuals more susceptible to overuse-type injuries in which microtrauma accumulates over time and repair in the older tissue does not keep pace with

repeated microtraumas. In the present prospective study, only about 14% of injuries were of the overuse type. Nonetheless, repetitive microtraumas coupled with slower repair processes may also weaken tissue to the point where sudden energy exchanges are more likely to cause acute (traumatic) tissue damage.

(c) Next, consider age-related declines in physical fitness. Aging results in a loss of muscle mass, muscle strength, muscular endurance, aerobic capacity, and flexibility.[199, 200] The loss of aerobic capacity and muscular endurance can begin as early as age 25 years.[200] These age-related changes reduce absolute fitness levels and may make injuries more likely since lower fitness has been shown to be consistently related to injury.[10, 11, 13, 16, 20, 23, 31, 32, 34, 36, 42, 43, 55-57] However, in the present study older age and lower aerobic fitness were independent injury risk factors when included in the multivariate model. Further, there was a low correlation between age and fitness: correlations between age and performance on push-ups, sit-ups, 300-meter sprint, and 1.5 mile run were -0.04, 0.00, 0.19, and 0.11, respectively, for the men; for women, these correlations were 0.09, 0.16, 0.04 and 0.11, respectively. Thus, the hypothesis that age-related declines in fitness alone account for the association between older age and injury is not strongly supported by data from the present investigation.

(d) Finally, consider age and prior injuries. It is possible that older individuals are more likely to have prior injuries that may make them more susceptible to future injuries. Prior injuries have been shown to be a risk factor for new injuries in many studies.[32, 95, 98, 201-209] To examine the hypothesis that prior injuries may make older agents more susceptible to injuries in training, self-reported prior injuries were stratified by age, as shown in Table 52. Injuries in training were higher in the older men, regardless of whether or not they reported a prior injury (lower or upper body). Results for the women were less clear, presumably because of the greater variability associated with the smaller sample size, but injury-in-training risk still tends to be higher in the older women regardless of whether or not they had a prior injury. In addition, both older age and a prior upper limb injury that still interfered with normal activity were both independent risk factors for training-related injuries in the multivariate analysis. Thus, the hypothesis that prior injury may make older individuals more susceptible to future injuries is not supported in FBI new agent training.

Table 52. New Agent Injuries in Training Stratified by Self-Reported Prior Injury and Age

Gender	Self-Reported Injury Type	Response Category	24.1-29.9 Year Olds		30.0-38.6 Year Olds		p-value[a]	Risk Ratio-Older/Younger (95%CI)
			N	% Injured in Training	N	% Injured in Training		
Men	Lower Limb Injury	No Reported Prior Injury	73	21.9	94	35.1	0.06	1.60 (0.96-2.67)
		Reported Prior Injury	115	29.6	144	45.8	<0.01	1.55 (1.11-2.16)
	Upper Limb Injury	No Reported Injury	113	23.9	135	37.0	0.03	1.55 (1.04-2.30)
		Reported Injury	75	30.7	103	47.6	0.02	1.55 (1.04-2.30)
Women	Lower Limb Injury	No Reported Injury	22	40.9	18	44.4	0.82	1.09 (0.52-2.23)
		Reported Injury	38	34.2	27	51.9	0.15	1.52 (0.86-2.68)
	Upper Limb Injury	No Reported Injury	45	37.8	28	46.4	0.47	1.23 (0.71-2.12)
		Reported Injury	15	33.3	17	52.9	0.27	1.59 (0.68-3.69)

[a]Chi-square statistic

(2) Physical Fitness.

(a) In the prospective data, FBI new agent data generally showed that higher levels of physical fitness were associated with lower levels of injury. While this was statistically significant only for the 300-meter run and the 1.5-mile run, injury risk was still higher in the lowest fitness quartile (men) or tertile (women) for all the fitness measures. In addition, slower 1.5-mile run time was an independent risk factor for injury in the multivariate analysis for both men and women.

(b) Of particular interest was the association between injuries and the total PFT point score. Both men and women who achieved at least 11-12 total PFT points were at lower injury risk than those who scored below 10 total points. In the retrospective study[1] we did not report total points. We re-analyzed the retrospective database to examine injury risk by total PFT points. Table 53 shows injury incidence by quartiles in the retrospective investigation.[1] In consonance with the present prospective findings, those who scored at least 11 total points had lower risk than those who scored 10 points or below. Among the women, injury risk was further reduced among those scoring at least 15 points.

Table 53. New Agent Injury Incidence (% Injured) by Physical Fitness Test Score in Retrospective Investigation

	-4-10 points	11-14 points	15-17 points	18-36 points	p-value[a]
Men (n=2837)	42	31	32	32	<0.01
Women (n=774)	46	40	35	35	0.06

[a]From chi-square test

(c) The finding that FBI new agents with lower fitness levels were at higher risk of injury agrees well with military basic training studies.[10, 11, 13, 16, 20, 23, 31, 32, 34, 36, 42, 43, 55-57] However, this finding does not agree with most studies of free living individuals[79, 81-87] which generally find the opposite, that individuals with higher fitness levels have higher injury incidence. One of the

common characteristics of military basic training and FBI new agent training is that individuals perform many physical activities with their fellow trainees. In the present prospective investigation, almost 60% of all injuries were associated with defensive tactics. All new agent trainees perform defensive tactics together and thus are exposed to similar risks. Twenty percent of injuries were associated with physical training in the present prospective investigation. New agent trainees who fail the initial PFT were required to attend supervised physical training (called "Power PT") three times per week and these new agent trainees would likely be performing very similar training. New agent trainees who passed the initial PFT were allowed to perform physical training on their own. Nonetheless, the types of physical training performed by these more fit new agents was likely similar to that of other new agents. This training likely involved both strength and aerobic training and focused, to a large extent, on passing the second PFT. It is possible that the relationship between low fitness and higher injury risk can be demonstrated in basic training and in new agent training (but not in civilian groups) because in these situations, the level and type of physical training are similar among participants.

(3) Tobacco Use.

(a) In the present study, little association was found between cigarette smoking and injury risk among the men or women. Only 13 men and 3 women who reported smoking even one cigarette in the 30 days before new agent training. Also, the amount of smoking reported was small, an average of 2 cigarettes per day for the men and 6 cigarettes per day for the women. The combination of the small number of smokers and low cigarette dosage may account for the lack of a relationship between cigarette smoking and injury. Previous military[12, 16, 43, 58, 59, 71, 108-110] and civilian investigations[77, 111-115] have shown that higher injury risk was associated with cigarette smoking, and that as the amount of smoking increases so does injury risk.[12, 16, 43, 58, 59, 108]

(b) Table 53 compares FBI new agents and military recruits[22, 23, 30] on responses to smoking-related questionnaire items. Questionnaire items were worded identically in all the investigations. Table 53 shows that FBI new agents and military recruits smoked their first cigarette at a similar average age. However, a much lower proportion of FBI new agents had smoked 100 cigarettes in their lifetime. FBI new agents who did smoke did so on fewer days, and consumed fewer cigarettes per day than military recruits.

Table 53. Comparison of Smoking Variables in FBI New Agents and Military Recruits (values are mean±standard deviation or %)

Questionnaire Item	Men				Women			
	FBI New Agents	Army Recruits[a]	Marine Corps Recruits[b]	Air Force Recruits[c]	FBI New Agents	Army Recruits[a]	Marine Corps Recruits[b]	Air Force Recruits[c]
Age Smoked First Cigarette (years)	17±3	16±3	16±3	16±3	17±3	16±3	15±3	16±3
Smoked 100 Cigarettes in Lifetime (%yes)	17	53	39	31	14	45	24	27
Days Smoked in Last 30 Days (days)	6±9	20±11	18±10	18±10	4±5	22±11	19±10	20±10
Cigarettes per Day in Last 30 Days (n)	2±3	9±8	8±12	7±8	6±8	8±6	7±7	8±7

[a]From reference [22]
[b]From reference [30]
[c]From reference [23]

(c) The Centers for Disease Control and Prevention (CDC) found that in 2008, 26% of men 22-44 years old and 21% of women 22-44 years old women reported smoking cigarettes. For those with undergraduate degrees, 12% of men and 10% of women reported smoking cigarettes. Smoking was defined as having smoked 100 cigarettes in one's life and smoking every day or on some days.[210] Applying the CDC smoking criteria to FBI new agents, we found that only 10 male new agents (2%) and 3 female new agents (3%) would be defined as smokers. Studies of law enforcement officers in various cities find smoking prevalence rates ranging from 12% to 51%.[88-90, 106, 107] Cigarette smoking prevalence was very low among FBI new agents compared to the general US population and other law enforcement groups.

(d) On the other hand, self-reported smokeless tobacco use among new FBI agents was similar to that in the general US population and among Army recruits. We found that 24 of 426 male FBI new agent (6%) and 1 of 105 female new agent (1%) reported using smokeless tobacco in the last 30 days. Data from the National Health Interview Survey indicated that in 2000, 6% of 25-44 year old men and 0.3% of women of all ages use smokeless tobacco on all or most days.[211] In US Army Basic Combat Training in 1998, 7% of men (16 of 221) and 1% of women (2/183) reported smokeless tobacco use.[55] In the present prospective study, smokeless tobacco use was not associated with injury. This agrees with a previous investigations in US Army Basic Combat Training,[55] but smokeless tobacco use has been found to increase injury risk in Norwegian basic training[43] and it is a risk factor for foot blisters.[138, 212]

(e) Somewhat perplexing was the higher injury risk among men who reported smoking at some point in their lives compared with those who had never smoked. Specifically, there was lower injury risk among men who reported smoking at least 100 cigarettes in their lives (questionnaire item number 9) or those who reported smoking at least 1 cigarette at some age (questionnaire item number 10) (Table 39). Not smoking at least 100 cigarettes in one's life was an independent risk factor for injury among new agents. This is in contrast to studies among Army,[22] Marine,[30] and Air Force[23] recruits where men who had not smoked at least 100 cigarettes in their lives or those who and had smoked at least 1 cigarette at some age had higher

injury risk in training. One difference in the FBI and military studies is that few FBI new agents are still smokers while a large proportion of military recruits continue to smoke. Many FBI new agents may have experimented with smoking in the past but did not smoke for long. In addition to smoking cessation, these individuals may have adopted other favorable health habits that may have reduced injury risk in training.

(f) Of interest was the fact that cigarette smokers and non-smokers had similar level of physical fitness as shown in Table 54. This is in consonance with Army data that shows that in younger individuals fitness levels do not differ, but at older ages (over 40 years) smokers tend to have lower aerobic fitness.[16, 22, 112, 213, 214]

Table 54. Physical Fitness in New Agent Smokers and Non-Smokers

	Men			Women		
	Smokers (n=13)	Nonsmokers (n=413)	p-value	Smokers (n=3)	Nonsmokers (n=102)	p-value
Push-Ups (n)	35±9	37±8	0.65	13±9	17±8	0.37
Sit-Ups (n)	44±4	44±5	0.72	38±10	42±6	0.27
300-Meter Sprint (sec)	45.6±2.5	45.9±2.4	0.66	57.0±2.6	56.1±3.0	0.61
1.5 Mile Run (min)	11.0±0.8	11.1±1.0	0.86	12.4±0.2	12.5±0.9	0.96
Total Score (points)	14.3±5.7	14.9±5.7	0.70	9.3±2.1	12.5±4.6	0.25

(4) Physical Activity and Self-Rated Fitness.

(a) Male new agent trainees were at greater injury risk if they rated themselves less physically active than their peers, reported that they performed aerobic exercise ≤ 1 time/week, or self-rated their endurance as less than average. Women had a similar trend for self rated physical activity and self rated endurance but these were not statistically significant, presumably because of the lower statistical power (fewer women in the sample); no women reported performing aerobic exercise ≤ 1 time/week. These data are similar to those reported by Nabeel et al.[215] who indicated that Minnesota police officers who self-reported higher fitness levels or more physically activity were less likely to report sprains, chronic pain or back pain. The data are also in consonance with previous studies in military training which have found that there is increased risk of injury among those who report lower self-reported physical activity relative to peers, [12, 16, 21, 22, 30, 32, 56] or lower frequency of aerobic activity.[12, 16, 22, 30] Physical activity of the proper intensity, frequency, and duration can increase aerobic fitness, muscle strength, and general health, and can reduce body fat.[216-220] Bone mineral density is higher in physically active individuals[109, 221-223] and higher bone mineral density has been associated with greater weekly physical activity.[222] These and other factors may contribute to reduced susceptibility to injury among more physically active individuals.[224]

(b) The American College of Sports Medicine (ACSM) recommends that to promote and maintain health, men and women 18-65 years old should perform moderate intensity aerobic

physical activity for at least 30 minutes on 5 days each week, or vigorous activity for at least 20 minutes on 3 days each week.[225, 226] To improve aerobic fitness (VO_2max), long-term physical activity should be conducted at intensities between 50 to 90% of VO_2max.[46, 227] Vigorous physical activity that promotes fitness would be most advantageous for FBI new agents because higher levels of fitness are associated with higher levels of occupational performance.[228-230] Data from the Behavioral Risk Factor Surveillance Study indicated that in 1998, only about 5% of Americans reported that they performed the ACSM recommended amount of vigorous activity.[231] ACSM also recommends that to promote and maintain good health, activities that increase muscular strength and endurance should be performed on two or more days per week.[225]

(c) The questionnaire responses of new agents to items on the frequency and duration of vigorous aerobic physical activity (Appendix C, Questions 20 and 21) were further examined. It was found that 95% of the men (405 of 426) and 96% of women (101 of 105) reported vigorous aerobic exercise at least 3 times per week for at least 16-30 minutes. Also, 78% of men (332 of 426) and 89% of women (93 of 105) reported vigorous aerobic exercise at least 3 times per week for at least 31-45 minutes. With regard to weight training, the questionnaire responses to the item on the frequency of weight training were examined (Appendix C, Question 22). It was found that 78% of men (332 of 426) and 77% of women (81/105) reported weight training at least twice per week in the two months before new agent training. Thus, a large proportion of new agents report favorable amounts of physical activity in the 2 months before entering the FBI Academy.

(d) Of interest was the finding that men who reported performing aerobic training 2-4 times per week were at lower injury risk than those who reported performing aerobic training $\leq$ 1 time/week or $\geq$5 times/week. Previous studies have shown that both low[12, 16, 22, 23, 30] and high[17, 60, 93-95, 99, 232, 233] levels of aerobic exercise will increase injury risk. It is possible that men who had a high frequency of physical activity prior to new agent training continued that level of aerobic activity while in new agent training, although this is speculative. If this was the case, this activity, combined with the required defensive tactics and other physical events, would have increased exposure to potentially injury-producing events. The present findings suggest that leaders should recommend a moderate frequency of vigorous aerobic activity (about 4 times per week) prior to new agent training.

(5) Prior Injury.

(a) Male FBI new agents who reported a prior upper or lower limb injury were at higher injury risk. If the new agent reported that the prior injury prevented normal activity for 1 week, or if they were not able to eventually return to 100% of normal activity, injury risk in training was further elevated compared with those who did not report these limitations. In addition, not returning to full activity after an upper limb injury was an independent risk factor for injury.

Much of defensive tactics training involved upper body physical activity and those with upper body limitations may be more susceptible to injury during this training. Other studies of military groups,[202, 203, 207] athletes,[95, 98, 204-206, 208, 209, 234] and industrial workers[201] have reported that prior injuries were associated with current injuries, especially if an injury had occurred in the preceding year.[95, 98, 205, 208, 209] Many injuries may be chronic or recurrent, accounting for at least a part of this relationship.

(b) Table 55 shows the proportion of individuals who reported prior injuries just before FBI new agent training or military basic training.[22, 23, 62] New agents reported a much higher incidence of prior lower limb injury compared with the military groups. The average age of the FBI new agents was about 30 years while the average age of the military groups ranged from 20 to 23years. The older age of the FBI new recruits may account for the higher prevalence of lower limb injury since FBI new agents would have more time at risk for injury.

Table 55. Proportion (%) of FBI New Agents and Military Recruit Reporting a Prior Lower Limb Injury

	Men (% Reporting Prior Lower Limb Injury)	Women (% Reporting Prior Lower Limb Injury)
FBI New Agents	61	62
Army Recruits[22]	15	14
Marine Recruits[62]	12	22
Air Force Recruits[23]	20	21

(6) Foot, Knee, and Back Pain Limiting Activity. Both men and women who self-reported foot, knee or back pain limiting activity tended to have elevated injury risk. This was statistically significant for foot and knee pain among the men and for back pain among the women, but reported pain in any of these areas tended to increase injury risk. In addition, among the men, knee pain that limited activity and, among the women, back pain that limited activity were independent risk factors for injury. It might be useful to screen prospective new agents on these or similar questions to further determine the nature of the limiting pain. Prophylactic measures might be considered to reduce the risk of injuries in training. For example knee bracing has been shown to reduce the incidence of sports injuries.[235-237]

(7) Injuries and Demographics.

(a) Men who were parents were at higher injury risk. It is possible that age confounded the relationship between injuries and parenthood and this was further explored. Of the men ≥30 years of age, 77% (141 of 183) had children and 23% (42 of 183) did not ($p<0.01$). Men without children had an average±SD age of 29.7±2.9 years old while those with children had an average±SD age of 32.5±2.9 years old ($p<0.01$). Table 56 shows that when men of similar ages were compared, injury incidence was similar among men with and without children. Finally, when parenthood and age were included in the multivariate Cox regression analysis, only age

was retained in the final model. Thus, the association between injuries and parenthood was likely due to the older age of those who were parents.

Table 56. New Agent Injuries in Training Stratified by Age and Parenthood (Men Only)

	No Children		Children		p-value[a]	Risk Ratio-Children/No Children (95%CI)
	n	Injured in Training (%)	n	Injured in Training (%)		
24.3-29.9 Years Old	146	27.4	42	23.8	0.64	0.86 (0.48-1.59)
30.0-37.0 Years Old	95	36.8	141	44.4	0.28	1.19 (0.86-1.65)

[a]Chi-square statistic

(b) Hispanic women were at higher injury risk than White or Black women. Hispanics have the highest rates of injury-related deaths among all ethnic groups in the United States but these deaths are predominantly male and associated with Hispanics holding high risk jobs, especially in the construction industry.[238, 239] Table 57 shows a comparison of physical characteristics and physical fitness of female new agents by race. While there was little difference in fitness among the racial groups, Hispanic women were shorter and tended to weigh less than women in other racial categories. The smaller size of the Hispanic women may have increased their injury risk, but neither height nor weight alone were injury risk factors. It is not clear why the Hispanic women were at higher injury risk.

Table 57. Comparison of Physical Characteristics and Physical Fitness by Race (Women Only)

	White (n=76)	Hispanic (n=9)	Asian (n=6)	Black (n=5)	p-value[a]
Age (yrs)	29.5±3.2	29.8±3.0	30.5±2.7	31.3±2.2	0.66
Height (inches)	65.7±2.6	63.3±1.5	64.5±2.3	66.6±3.6	0.04
Weight (lbs)	136.5±17.2	126.8±14.8	138.0±24.8	145.2±9.1	0.26
BMI (kg/m^2)	22.2±2.1	22.2±1.8	23.2±3.0	23.2±2.7	0.56
Push-Ups (reps)	16±8	16±6	16±4	20±9	0.83
Sit-Ups (reps)	41±6	39±7	41±5	43±6	0.63
300-m Sprint (sec)	56.0±3.1	56.7±2.3	57.0±2.8	54.0±2.3	0.37
1.5-Mile Run (min)	12.4±0.9	12.8±0.6	13.0±1.0	13.0±0.7	0.12
Total Score (points)	12.8±4.8	10.2±3.1	9.8±3.9	14.0±5.1	0.18

[a]From one-way analysis of variance

(d) Women with military experience were less likely to get injured than women without military experience. It is possible that women with military experience had higher levels of fitness and/or performed more physical activity as a result of their military experience. However, this hypothesis was not supported by the data. As shown in Table 58, former military women had PFT test scores similar to their counterparts without military experience. Also, former military women and those without military service reported similar exercise and sports training frequencies as shown in Table 58. Thus, the hypothesis that former military women were more physically fit or physically active relative to women without military experience was not supported. It is not clear why former military women were less likely to be injured.

Table 58. Initial Fitness Scores of New Agent Women Based on Military Experience

	Push-Ups (n)	Sit-Ups (n)	300-Meter Sprint (sec)	1.5-Mile Run (min)	Total Score (Points)
Military Experience (n=18)	17±9	43±6	56.5±2.9	12.4±0.6	12.7±4.7
No Military Experience (n=86)	16±7	41±5	56.1±3.0	12.5±1.0	12.3±4.6
p-value[a]	0.60	0.22	0.58	0.78	0.74

[a]From independent sample t-test

Table 59. Exercise Frequency of New Agent Women Based on Military Experience

	Frequency (times/week)	Military Experience (%) (n=18)	No Military Experience (%) (n=86)	p-value[a]
Aerobic Training	2-4/week	66.7	50.0	0.20
	≥5/week	33.3	50.0	
Weight Training	≤1/week	22.2	23.3	
	2-4/week	72.2	69.8	0.97
	≥5/week	5.6	7.0	
Sports	≤1/week	94.4	84.9	0.28
	2-4/week	5.6	15.1	

(e) Finally, women who were left handed were more likely to get injured and this was an independent risk factor for injuries in the multivariate analysis. Previous literature has supported the concept that left-handed individuals are more susceptible to injury.[240, 241] One hypothesis to account for this relationship is that the design of environments, tools, machines and the like favor the right-handed majority. Left-handed individual must use their less favored hand to perform tasks, adopt unfavorable postures, and/or generally function in environments that place them in less than optimal positions compared with their right-handed peers.

e. Limitations.

(1) Injury diagnoses were limited to descriptions in the medical records. Many of these did not involve diagnostic tests that would have provided definitive diagnoses. Further, 9% of all injuries were obtained from CA-1s alone indicating that some injuries were not captured in the medical record database. However, inclusion of the CA-1 data made the injury capture more comprehensive than in the retrospective investigation. The injury incidence, injury diagnoses and anatomic locations in the retrospective and prospective investigations were similar which suggests the findings are reliable. The data provide a representative look at medical encounters and shows a high incidence of strains, sprains, contusions and lacerations which are common injuries in physically active populations.[12, 13, 170-178]

(2) This investigation identified a number of risk factors for injuries in new agent training. However, this analysis identifies only associations between injuries and other factors; cause-and-effect relationships are not implied. This is illustrated by the association between parenthood and injuries which was found to be confounded by age. Further, statistical power was limited in analyses involving the women because of the small number.

(3) Data on tobacco use, physical activity, prior injury, and other questionnaire variables were based on self-reports which could be subject to recall bias. Nonetheless, the data on physical activity and prior injury support prior findings in military and other groups. Further, recall periods for many questions were limited to 30-60 days which has been shown to improve the validity of the data.[242-244] The small number of tobacco users, although favorable from a health perspective, limited the ability to find associations between tobacco use and injury, if indeed such a relationship exists among FBI new agents.

8. RECOMMENDATIONS. The recommendations here combine information from both the retrospective and prospective investigations so that a single document contains them both. Where the recommendation stems from the retrospective investigation this is stated.

a. New agent trainees should be encouraged to arrive at the FBI Academy with an entry level PFT score of 12 for men and 15 for women. Scores below these levels were associated with higher injury risk, while scores above these levels were associated with lower injury risk. Encouraging a high level of aerobic fitness appears to be of particular importance since this was an independent injury risk factor.

b. Encourage a moderate amount of aerobic exercise prior to and during new agent training. Over 95% of men and women reported performing at least the minimal recommended amount of vigorous aerobic activity and over 75% reported the recommended frequency of weight training. Results from the present prospective investigation suggest that either too much or too little aerobic exercise prior to new agent training increases injury risk and this is supported by the medical literature. A recommended frequency of aerobic activity is 3-4 times/week prior to new agent training. The present prospective investigation does not provide data that would target a recommendation for the duration of aerobic activity to reduce injury risk but based on recommendations from the American College of Sports Medicine the duration should be 20-30 minutes each time. Individuals should consider high-intensity interval type training since this can also improve both aerobic and anaerobic capability as well as speed which may assist with other activities (e.g., 300-meter run).[245-248]

c. Emphasize the association between low fitness and higher injury risk to new agent trainees and to FBI field offices. In both the retrospective and prospective investigations lower physical fitness was associated with higher overall injury risk; in the retrospective study, lower fitness was also associated with a higher incidence of exertion and rhabdomyolysis. This suggests that the higher the fitness level the lower the risk of injury at the FBI Academy. The FBI literature used to prepare new agent trainees for the academy already emphasizes that physical fitness is important for new agent trainees and provides a suggested physical training program. Quantitative information from this project should be included in that literature.

d. Continue statistical analysis of PFT failure rates and continue to provide these reports to field offices. In the retrospective study, aerobic fitness (1.5-mile run times) showed some improvement from FY04 to FY09 and there was no decline on other PFT scores. During at least a portion of this period (FY05-FY09), statistical reports were sent to field offices comparing failure rates among the field offices. It is possible that this motivated field offices to more adequately prepare new agent trainees in terms of their physical fitness. Note that the improvement in new agent aerobic fitness is in contrast to other investigations worldwide reporting declines in aerobic fitness over the years.

e. Examine defensive tactics training to determine whether injury risk can be reduced. By far, the largest numbers of injuries were associated with defensive tactics training in both the retrospective and prospective investigations. This is not surprising given the physically aggressive nature of the training and the exposure to potential traumatic events. We observed that many safety measures were already in place (e.g., cushioned mats, use of headgear and mouthguards during boxing) and that the physical training staff was quite knowledgeable and alert to safety concerns. Nonetheless, defensive tactics should be further reviewed to determine whether additional safety measures can be implemented.

f. Improve collection of information on injury mechanisms. When a new agent trainee presents at the clinic for an injury, information should be recorded in the medical record on both the activity associated with the injury and the mechanism of injury. Mechanism notes should include exactly how the injury occurred. This might include simple notes like "another student hyperextended patient's arm during the handcuffing exercise in defensive tactics." This includes both the training activity (defensive tactics, handcuffing) and the mechanism of injury (hyperextension of the arm).

g. Use the most common injuries identified here and in the retrospective investigation to assist in medical planning. In both investigations these injuries included strains, sprains, contusions, and abrasions/lacerations.

h. Remain vigilant for symptoms of exertional rhabdomyolysis (ER). No cases of rhabdomyolysis occurred during the period of this prospective investigation possibly because physical trainers and medical staff were aware of this potential problem. ER often occurs with excessive or unusual exercise in unconditioned individuals, especially early in training. Physically fit individuals can also suffer from ER if they do an excessive amount of activity for which they have not specifically trained. Although ER is an infrequent diagnosis, the Physical Training Unit as well as medical providers should remain knowledgeable about this problem and aware of the symptoms. New agent trainees may complain of muscle pain and limited physical ability and may assume it is just normal delayed onset muscle soreness. Agents with persistent symptoms or symptoms that exceed those of delayed onset muscle soreness should be escorted to

the medical clinic so that their symptoms can be properly diagnosed. More details on signs, symptoms, and acute care are provided in the background section of this paper.

i. Continue investigating associations between prior injury and pain that limits activity.

(1) Self-reported prior injury in the upper or lower body was associated with higher injury risk, especially if the new agent reported that he or she had not returned to full activity after these previous injuries. The nature of these prior injuries (type, anatomical location, causes, and the like) should be explored more fully to determine whether prophylactic measures can be put in place to reduce injury risk in training.

(2) Self-reported knee, ankle and back pain that limited activity was associated with higher injury risk. Additional information should be collected to more fully define these problems to determine whether prophylactic measures might reduce injury risk in training. For example, knee bracing has been shown to be an effective intervention to reduce injuries.

APPENDIX A. REFERENCES

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APPENDIX B.
INTERAGENCY AGREEMENT

INTERAGENCY AGREEMENT BETWEEN
THE FEDERAL BUREAU OF INVESTIGATION AND
ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

I. Purpose: This interagency agreement establishes terms and conditions of an agreement between the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) and the Federal Bureau of Investigation (FBI) to examine available injury data and investigate the nature of injury causation and prevention at the FBI Academy, Quantico, Virginia. The principal focus will be the New Agent Training Program (NATP) but the epidemiologic scope may be expanded during the course of this agreement to other training entities by mutual agreement.

II. Authority /References:

a. DOD Instruction 4000.19, Interservice and Intergovernmental Support, 9 Aug 1995

b. USACHPPM Regulation 37-1, Reimbursable and Defense Health Program Orders, 1 Aug 2000

c. DOD Regulation 6025-18, DOD Health Information Privacy Regulation, 24 Jan 2003

d. Title 31, United States Code, Section 1535, Economy Act

e. Title 42, United Stated Code, Section 3771, Training and Manpower Development

III. Background:

The FBI's Human Resources Division, Office of Medical Services, Health Care Programs Unit (HCPU), has requested the assistance of the CHPPM to apply their longstanding experience in injury prevention programs in military training to the assist injury prevention in the FBI's NATP at the FBI Academy, Quantico, Virginia. CHPPM representatives traveled to FBI Headquarters on April 24, 2008 for initial discussions. Several questions were raised regarding the availability and accessibility of the necessary data. A meeting was subsequently hosted by the FBI's Assistant Director, Training Division on May 19,2008. CHPPM briefed Training Division and FBI Headquarters managers on previous experience and proposed methodology. CHPPM personnel were provided a tour of the FBI Academy medical and training areas to further determine the achievability of the project. CHPPM and FBI representative concluded that the project was feasible because data since 1999 appear to be available in an isolated medical computer database.

IV. Scope:

This agreement applies to the FBI's Human Resources Division, Office of Medical Services, HCPU and Training Division, FBI Academy, and to the CHPPM Directorate of Epidemiology and Disease Surveillance.

The FBI will provide information and availability of students for interview so that the CHPPM can examine injury rates, determine injury risk factors, and provide recommendations for the prevention of injuries during the NATP. An ongoing relationship is desired to allow periodic follow-up of the results of interventions for continued improvement and interaction with the aerobic and physical content of FBI training programs.

V. Responsibilities:

a. The FBI shall:

(1) Provide a list of all current New Agent Trainees (NATs), containing first name, last name, social security number, and class number. Provide the names and contact information for the counselors for these current classes.

(2) Provide access to two groups of NATs for focus group interviews lasting one hour for each group. One group should be relatively new (2-4 weeks in training), while the other group should be nearing the completion of training (14-17 weeks). Groups should include at least 5 NATs, but 10 NATs would be optimal.

(3) Provide access to the paper medical records of current NATs so demographic information (race, date of birth, height, and entry weight) can be obtained from available forms. Provide access to the computerized medical records of the clinic from 1999 forward so that injury data can be obtained to map rates and trends of injuries over time. Of special interest for each injury is the date of the visit, diagnoses, anatomical location, activity associated with the injury, disposition, and class number. Provide access to the CA-I forms so location, cause, and nature of reported injuries can be obtained.

(4) Provide all physical fitness test (PFT) scores for current NATs. Provide PFT scores for previous NA T classes from 1999 forward, if available. These should be raw scores (number of push-ups, number of sit-ups, run times in minutes, etc.), if available. If points are available these should also be provided. PFT scores for weeks 1, 7 and 14 should be provided, if available.

(5) Provide access to all current classes of NATs so that a questionnaire can be administered. The questionnaire is necessary because some potential injury risk factors can only be obtained directly from the NATs.

(6) Provide data on injuries that result in recycling of NATs in the current classes and classes from 1999 forward, if available.

(7) Provide other available demographic data for the current classes, as available. Demographic data might include variables like age, gender, marital status, educational level, number of dependents, and other information. These are potential injury risk factors.

(8) Provide, to the extent possible, printed materials describing the program of instruction for firearms, physical training, and practical applications. This would include training defining the physical activities performed by NATs.

b. CHPPM shall:

(1) Keep confidential all NAT personal information and not release the information to any other person or agency without direct permission from the FBI. All medical information will be handled in compliance with Health Insurance Portability and Accountability Act (HIPAA) standards as defined in Paragraph 7. Only HIPAA-trained personnel will process/analyze the data.

(2) Construct a questionnaire that will ask the NATs about their fitness perceptions, physical activity prior to the academy, tobacco use prior to the academy, and (for women) menstrual history. The FBI will review the questionnaire, provide input, and approve the final copy.

(3) Construct a database that will be used for the analysis of the data. All personal identifiers will be removed from the database before that database leaves the FBI training site at Quantico VA.

(4) Provide descriptive data (means, standard deviations, frequencies) on all variables obtained.

(5) Analyze provided data to determine injury rates, activities associated with injury, and injury risk factors, to the extent these factors can be determined from available data.

(6) Provide both a retrospective and prospective analysis of available data. The retrospective analysis will involve showing injury rates by year of training. The prospective analysis will include an examination of the current classes to determine current injury rates, activities associated with injury, and injury risk factors. All fitness, demographic, and questionnaire data will be analyzed to determine the extent to which these variables are associated with injury.

(7) Provide an analysis of injury trends over the years of available data.

(8) Provide an analysis of fitness trends over the years of available data.

(9) Provide evidence-based suggestions for reducing injuries in the New Agent Training Program.

(10) Provide a final written report and briefing within nine months after first authorized entry into the FBI Academy to conduct the study.

VI. Resources:

The FBI shall provide to the CHPPM $65,678 to cover the costs of obtaining the data, analyzing the data, and preparing the final report and briefing. This will be a one-time cost provided in a lump sum. The exact breakdown of the costs in included in the attached Department of Defense Form 1144.

VII. Privacy and Security of Protected Health Information (PHI):

a. Terms used in this section shall have the same meaning as those terms in 45 CFR part 160 and part 164 and/or DOD Regulation 6025.18-R, DOD Health Information Privacy Regulation.

b. CHPPM Obligations and Activities. The CHPPM:

(1) Will not use of disclose PHI other than as permitted or required by agreement or law.

(2) Will use appropriate safeguards to prevent use or disclose of PHI other than as provided for by this agreement.

(3) Will implement administrative, physical, and technical safeguards that reasonably and appropriately protect the confidentiality, integrity, and availability of the electronic PHI that is creates, received, maintains, or transmits on behalf of the Government.

(4) Will report to the FBI any use or disclosure of the PHI not provided for by this agreement or any security incident of which it becomes aware.

(5) Will ensure that any agent to whom it provides electronic PHI that it creates, receives, maintains, or transmits on behalf of the Government, agrees to the same restrictions and conditions that apply through this agreement to the CHPPM with respect to such information and will implement reasonable and appropriate safeguards to protect it.

(6) Will mitigate, as practicable, any harmful effect known to the CHPPM of a security incident or use/disclosure of PHI by the CHPPM in violation of the requirements of this agreement.

(7) Will provide access, at the request of the Government, in order to meet the requirement of 45 CFR 164.524.

(8) Will make any amendment(s) to PHI in a Designated Record Set that the Government directs or agrees to pursuant to 45 CFR 164.526.

(9) Will make available internal practices, books, and records relating to the use and disclosure of PHI for purposes of the Secretary, Health and Human Services determining the Government's compliance with the Privacy or Security Rule.

(l0) Agrees to document such disclosures of PHI and information related to such disclosures as would be required for the Government to respond to a request by an individual for an accounting of disclosure of PHI in accordance with 45 CFR 164.528.

(11) Agrees to provide to the Government or an Individual information collected in accordance with the Clause to permit the government to respond to a request by an Individual for an accounting of disclosures of PHI in accordance with 45 CFR 164.528.

c. Except as otherwise limited in this agreement, the CHPPM:

(1) May use or disclose PHI to perform functions or services for, or on behalf of, the FBI as specified in this agreement, provided that such use or disclosure would not violate the Privacy Rule if performed by the FBI. May create, receive, maintain, or transmit electronic PHI on behalf of the FBI as specified in this agreement, provided such action would not violate the Security Rule if performed by the FBI.

(2) May use PHI for the proper management and administration of the CHPPM or to carry out the legal responsibilities on the CHPPM.

(3) May disclose PHI for the proper management and administration of the CHPPM, provided that disclosures are required by law, or the CHPPM obtains reasonable assurances from the person to whom the information is disclosed that it will remain confidential and used or further disclosed only as required by law or for the purpose for which it was disclosed to the person, and the person notifies the CHPPM of any instances of which it is aware in which the confidentiality of the information has been breached.

(4) May use PHI to provide Data Aggregation services to the Army as permitted by 45 CFR 164.504(e)(2)(i)(B).

(5) May use PHI to report violations of law to appropriate Federal and State authorities, consistent with 45 CFR 164.522.

d. Obligations of the FBI. The FBI:

(l) Upon request shall provide the CHPPM with the notice of privacy or security practices that the FBI medical facility produces, as well as any changes to such notice.

(2) Shall provide the CHPPM with any changes in, or revocation of, permission by individual to use or disclose PHI, is such changes affect the CHPPM's permitted or required uses and disclosures.

(3) Shall notify the CHPPM of any restriction to the use or disclosure of PHI that FBI has agreed to in accordance with 45 CFR 164.522.

e. A breach of this clause by the FBI or CHPPM may be ground to terminate the agreement in accordance with termination provisions contained herein.

f. Any ambiguity in this clause shall be resolve in favor of a meaning that permits the Government to comply with the Health and Human Services Final HIPAA Privacy and Security Rules.

g. The current NATs who agree to participate in this examination of injury data will sign a separate consent agreement that basically says "I agree to participate in the examination of injury rates at the FBI Academy that is being undertaken by the FBI and CHPPM. I consent to being interviewed for this purpose and providing access to my medical and demographic information, with the understanding that

CHPPM will deidentify the data before removing it from FBI premises, will keep any resultant data confidential, and will only share such deidentified data with another agency or individual with the express permission of the FBI."

VIII. Period of Agreement:

This agreement becomes binding and enters into force upon signature by both parties and for a period of five years unless superseded or terminated. Prior notice of 180 days will be provided if the agreement is to be suspended or terminated. Modifications will be made by mutual consent of both parties with annual review of anticipated activity and additional funding requirements beyond the scope of activity currently specified.

IX. Project Officers:

For FBI:
Margaret M. Grey
Unit Chief, Health Care Programs Unit
FBIHQIHCPU, Rm 6344
935 Pennsylvania Avenue, NW
Washington, DC 20535
(202) 324-4976; FAX (202) 324-2923
margaret.grey@ic.fbi.gov

For DOD:
Dr. Joseph Knapik
U.S. Army Center for Health Promotion and
Preventive Medicine, MCHB-TS-DI
1570 Stark Road
Aberdeen Proving Ground, MD 21010
(410) 436-1328; FAX (410) 436-5449
joseph.knapik@us.army.mil

X. Funding:

The FBI shall provide to CHPPM $65,678 to cover the costs of obtaining the data, analyzing the data, and preparing the final report and briefing, as detailed in Department of Defense Form 1144 as an attachment. Additional funding for continuation of epidemiology services following the initial analysis of historical data will be based upon an updated estimation of the cost of services and by mutual agreement.

XI. Billing Instructions:

The FBI will send payment via direct fund cite to: USACHPPM ATTN: MCHB-TS-DI 1570 Stark Road Aberdeen Proving Ground, MD 210I0

XII. Approvals:

Federal Bureau of Investigation:

Walter Meslar
Contracting Officer, Finance Division
Date: 21 January 2009

Epidemiological Report No. 12-HF-97HRF1A-10, MARCH 2009-MARCH 2010

Donald Packham
Executive Assistant Director Human Resources Branch
Date: 29 January 2009

US Army Center for Health Promotion and Preventive Medicine:

Steven Brewster
LTC(P), MC
Director, Epidemiology & Disease Surveillance
Date: 15 December 2008

APPENDIX C.
Lifestyle Questionnaire

PRIVACY ACT STATEMENT – HEALTH CARE RECORDS, FITNESS TEST SCORES, AND QUESTIONNAIRE

1. AUTHORITY FOR COLLECTION OF INFORMATION INCLUDING SOCIAL SECURITY NUMBER

Public Law 104-191, Section 1178; Executive Order 9397; Section 8103, Title 5, United States Code

2. PRINCIPLE PURPOSES FOR WHICH INFORMATION IS INTENDED TO BE USED

This form provides you the advice required by the Privacy Act of 1974. Your personal information will facilitate tracking the health, fitness, and functional status of Federal Bureau Of Investigation (FBI) New Agent Trainees with regard to injuries. The information you agree to provide is your health records and fitness test scores during the time you serve as a New Agent Trainee. Your Social Security Number (SSN) is required to retrieve your health records and physical fitness test scores and link these data. A questionnaire will be administered to aid in determining how lifestyle factors affect the health of New Agent Trainees.

3. ROUTINE USES

The primary use of this information is to improve the health and fitness of FBI New Agent Trainees. Your health records, fitness test scores, and questionnaire responses will be included in a database that contains the same information for all New Agent Trainees. The only personnel having access to this information will be the public health officials who analyze the information. The information will not be disclosed to any other person or agency (other than the FBI which already has these data). You will not be personally identified in any report or by another other method since the topic of interest is the health and fitness of the New Agent Trainee population, not the health and fitness of any single individual.

The database created with the information you provide will identify current level of fitness, current injury trends, and factors that put New Agent Trainees at risk of injury. The database will allow tracking of fitness, injury trends, and injury risk factors over time. The results from analysis of these data will be used to make recommendations to decision makers regarding programs and policies that might improve fitness and reduce the incidence of injury among New Agent Trainees. The information will also be used to evaluate the effectiveness of those recommendations when implemented.

4. WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION

Disclosure of the requested information is voluntary. By disclosing the information you agree to participate in the examination of injury rates at the FBI Academy, consent to being interviewed for this purpose and consent to provide access to your medical and demographic information. The information will be deidentified, will be kept confidential, and the deidentified data will be shared with another agency or individual only with the express permission of the FBI. If you do not disclose the information you will not be included in the database and you will not participate in the project designed to reduce injuries, identify risk factors and improve the health and fitness of New Agent Trainees.

SIGNATURE OF PARTICIPANT	SSN OF PARTICIPANT	DATE

FBI Training & Musculoskeletal Injuries: **New Agent Trainee Survey**

- **In this questionnaire, you will be asked about yourself and your lifestyle.**
- **Please answer each question to the best of your ability.**

Background Details

1. Today's date: |___|___| / |___|___| / |___|___|___|___|
   Month Day Year
2. What is the number of your NAT class? _____
3. What is your name? _____
   Last name, First name, Middle initial
4. What is your social security number? |___|___|___|–|___|___|–|___|___|___|___|
5. What is your birth date? |___|___| / |___|___| / |___|___|___|___|
   Month Day Year
6. Are you…
   ☐ 0 Male
   ☐ 1 Female
7. What is your Height? |___| feet |___| |___| inches
8. What is your Weight? |___| |___| |___| pounds

Tobacco Use

9. Have you smoked at least 100 cigarettes in your life? (100 cigarettes = 5 packs)
   ☐ 1 YES
   ☐ 0 NO
10. About how old were you when you smoked a whole cigarette for the first time?
    (If you have never smoked a whole cigarette, write 00)
    |___|___| years old
11. During the past 30 days, on how many days did you smoke a cigarette?
    (If you have not smoked in the last 30 days, write 00)
    |___|___| days
12. During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day on average?
    (If you have not smoked in the last 30 days, write 00)
    |___|___| cigarettes

13. If you used to smoke cigarettes and quit, how many months or years ago did you quit?
(If you have never smoked or are currently smoking, write 00)

|___|___| months OR |___|___| years

14. If you are currently smoking, how many years have you been smoking?
(If you are not currently smoking, write 00)

|___|___| years

15. During the past 30 days, on how many days did you use smokeless tobacco (chewing, snuffing, pinching, etc)?
(If you have not used smokeless tobacco in the last 30 days, write 00*)*

|___|___| days

16. During the past 30 days, on the days you used smokeless tobacco, how many cans, pouches, or plugs did you use per day, on average?
(If you have not used smokeless tobacco in the last 30 days, write 0)

|____| cans, pouches, or plugs

17. If you used to use smokeless tobacco and quit, how many months or years ago did you quit?
(If you have never used smokeless tobacco or are currently using, write 00)

|___|___| months OR |___|___| years

18. If you are currently using smokeless tobacco, how many years have you been using smokeless tobacco?
(If you are not currently using smokeless tobacco, write 00)

|___|___| years

Physical Activity

19. Compared with others your same age and sex, how would you rate yourself on the amount of physical activity you performed before entering New Agent Training?

☐ 1 Much less active
☐ 2 Somewhat less active
☐ 3 About the same
☐ 4 Somewhat more active
☐ 5 Much more active

20. In the 2-month period before New Agent Training, how many **times per week** on average, did you

perform vigorous aerobic exercise (such as running, jogging, cycling, etc.)?

- ☐ 0 Never
- ☐ 1 Less than 1 time per week
- ☐ 2 1 time per week
- ☐ 3 2 times per week
- ☐ 4 3 times per week
- ☐ 5 4 times per week
- ☐ 6 5 times per week
- ☐ 7 6 times per week
- ☐ 8 7 or more times per week

21. When you performed vigorous aerobic activity in the 2 months before New Agent Training, what was the average **amount of time** that you exercised during each session?

- ☐ 0 None, did not do aerobic exercise
- ☐ 1 1–15 minutes
- ☐ 2 16–30 minutes
- ☐ 3 31–45 minutes
- ☐ 4 46–60 minutes
- ☐ 5 61–75 minutes
- ☐ 6 76–90 minutes
- ☐ 7 More than 90 minutes

22. In the 2 months before New Agent Training, how many **times per week**, on average, did you do weight training (such as free weights, universal, nautilus, etc.)?

- ☐ 0 Never
- ☐ 1 Less than 1 time per week
- ☐ 2 1 time per week
- ☐ 3 2 times per week
- ☐ 4 3 times per week
- ☐ 5 4 times per week
- ☐ 6 5 times per week
- ☐ 7 6 times per week
- ☐ 8 7 or more times per week

23. When you performed weight training in the 2 months before New Agent Training, what was the

average **amount of time** that you trained during each session?

- ☐ 0 None, did not do weight training
- ☐ 1 1–15 minutes
- ☐ 2 16–30 minutes
- ☐ 3 31–45 minutes
- ☐ 4 46–60 minutes
- ☐ 5 61–75 minutes
- ☐ 6 76–90 minutes
- ☐ 7 More than 90 minutes

24. In the 2 months before New Agent Training, how many **times per week**, on average, did you play sports?

- ☐ 0 Never
- ☐ 1 Less than 1 time per week
- ☐ 2 1 time per week
- ☐ 3 2 times per week
- ☐ 4 3 times per week
- ☐ 5 4 times per week
- ☐ 6 5 times per week
- ☐ 7 6 times per week
- ☐ 8 7 or more times per week

25. When you played sports in the 2 months before New Agent Training, what was the average **amount of time** that you played each time?

- ☐ 0 None, did not play sports
- ☐ 1 1–15 minutes
- ☐ 2 16–30 minutes
- ☐ 3 31–45 minutes
- ☐ 4 46–60 minutes
- ☐ 5 61–75 minutes
- ☐ 6 76–90 minutes
- ☐ 7 More than 90 minutes

Physical Fitness

26. Rate your physical fitness just before entering New Agent Training on each of the following, compared with others of your age and sex:

	Far Less Than Average	Less Than Average	Average	Greater Than Average	Far Greater Than Average
Endurance	☐	☐	☐	☐	☐
Sprint Speed	☐	☐	☐	☐	☐
Strength	☐	☐	☐	☐	☐
Flexibility	☐	☐	☐	☐	☐
Push-Ups	☐	☐	☐	☐	☐
Sit-Ups	☐	☐	☐	☐	☐
Body Fat	☐	☐	☐	☐	☐

Injury History

27. Prior to New Agent Training, did you ever injure bone, muscle, tendon, ligaments, and/or cartilage in one or both of your lower limbs (feet, ankles, legs, knees, or hips)?

☐ 1 YES
☐ 0 NO

28. Did any of these lower limb injuries prevent you from participating in your normal physical activities for at least one week?

☐ 7 Does not apply, never had lower limb injury
☐ 1 YES
☐ 0 NO

29. Following these lower limb injuries, were you able to eventually return to 100% of your normal physical activities?

☐ 7 Does not apply, never had lower limb injury
☐ 1 YES
☐ 0 NO

30. Prior to New Agent Training, did you ever injure bone, muscle, tendon, ligaments, and/or cartilage in one or both of your upper limbs (hands, wrist, arms, elbows, or shoulders)?

☐ 1 YES
☐ 0 NO

31. Did any of these upper limb injuries prevent you from participating in your normal physical activities for at least one week?

☐ 7 Does not apply, never had upper limb injury
☐ 1 YES
☐ 0 NO

32. Following these upper limb injuries, were you able to eventually return to 100% of your normal physical activities?

☐ 7 Does not apply, never had upper limb injury
☐ 1 YES
☐ 0 NO

33. In the year prior to New Agent Training, did you have foot pain that caused you to limit your daily activity some of the time?

☐ 1 YES
☐ 0 NO

34. In the year prior to New Agent Training, did you have knee pain that caused you to limit your daily activity some of the time?

☐ 1 YES
☐ 0 NO

35. In the year prior to New Agent Training, did you have back pain that caused you to limit your daily activity some of the time?

☐ 1 YES
☐ 0 NO

If you are a **man**, stop here. Thank you for completing this questionnaire.

If you are a **woman**, complete the questions on the next page.

Female Questions

36. At what age did you start to menstruate?
(If you have not had a menstrual period, write 00)

|___|___| years

37. Over the last 12 months, how many menstrual periods did you have?
(If you have not had a menstrual period, write 00)

|___|___| menstrual periods

38. During the last 12 months, have you missed 6 or more months in a row between menstrual cycles?

☐ 7 N/A, I never had a menstrual period
☐ 1 Yes, I missed 6 months or more in a row between menstrual cycles
☐ 0 No, I did not miss 6 or more months in a row between menstrual cycles

39. In the last 12 months, have you taken birth control pills?

☐ 1 YES
☐ 0 NO

40. In the last 12 months, have you taken any hormonal therapy other than birth control pills?

☐ 1 YES
☐ 0 NO

41. If you have ever been pregnant, how many months or years ago were you last pregnant?
(If you have never been pregnant, write 00)

|___|___| months OR |___|___| years

Thank you for completing this questionnaire

APPENDIX D.
New Agent Trainee Profile Form

NEW AGENT TRAINEE PROFILE
NAC 09-09

NAME: _____ NICKNAME: _____ SEX: _____

ROOM #/EXTENSION: _____ HOMETOWN: _____

HEIGHT: _____ WEIGHT: _____ AGE: _____

SPOUSE'S NAME: _____ CHILDREN/AGE: _____

PROCESSING OFFICE: _____
PROGRAM: Diversified ☐ Language ☐ CS/IT ☐ Tactical ☐

Law ☐ Science ☐ Intelligence ☐ Engineering ☐
Accounting/Finance ☐

COLLEGE (SCHOOL, CITY, STATE): _____
DEGREE/MAJOR FIELD OF STUDY: _____
GRADUATE SCHOOL (SCHOOL, CITY, STATE): _____
DEGREE/MAJOR FIELD OF STUDY: _____
PREVIOUS EMPLOYMENT (ORGANIZATION/POSITION/LENGTH OF SERVICE): _____

FOREIGN LANGUAGE: _____ PROFICIENCY LEVEL: _____
MILITARY EXPERIENCE (BRANCH/SPECIALTY/RANK/YEARS/MONTHS): _____

LAW ENFORCEMENT EXPERIENCE (DEPT/ASSIGNMENT/RANK/YEARS): _____

FIREARMS EXPERIENCE: _____
DOMINANT HAND: _____ DOMINANT EYE: _____
TACTICAL TRAINING: _____
DRIVING EXPERIENCE: (FREQUENCY & DURATION OF DRIVING A VEHICLE, I.E., DAILY, MONTHLY, YEARLY

DRIVER'S LICENSE NO.: _____ STATE: _____ EXP. DATE _____
ATHLETIC HISTORY: _____
CURRENT FITNESS PROGRAM: _____
SERIOUS ENCOUNTERS: _____

INJURIES: _____
HOBBIES/INTERESTS: _____

Appendix E. Standard Form 88 (Report of Medical Examination)

MEDICAL RECORD	REPORT OF MEDICAL EXAMINATION	DATE OF EXAM

1. LAST NAME - FIRST NAME - MIDDLE NAME	2. IDENTIFICATION NUMBER	3. GRADE AND COMPONENT OR POSITION
4. HOME ADDRESS *(Number, street or RFD, city or town, state and ZIP Code)*	5. EMERGENCY CONTACT *(Name and address of contact)*	
6. DATE OF BIRTH / 7. AGE	8. SEX ☐ FEMALE ☐ MALE	9. RELATIONSHIP OF CONTACT
10. PLACE OF BIRTH	11. RACE ☐ WHITE ☐ BLACK ☐ AMERICAN INDIAN/ALASKA NATIVE ☐ HISPANIC WHITE ☐ HISPANIC BLACK ☐ ASIAN/PACIFIC ISLANDER	
12a. AGENCY	12b. ORGANIZATION UNIT	13. TOTAL YEARS GOVERNMENT SERVICE: a. MILITARY / b. CIVILIAN
14. NAME OF EXAMINING FACILITY OR EXAMINER, AND ADDRESS	15. RATING OR SPECIALTY OF EXAMINER 16. PURPOSE OF EXAMINATION	

17. CLINICAL EVALUATION

NORMAL	(Check each item in appropriate column, enter "NE" if not evaluated.)	ABNORMAL	NORMAL	(Check each item in appropriate column, enter "NE" if not evaluated.)	ABNORMAL
	A. HEAD, FACE, NECK AND SCALP			O. PROSTATE *(Over 40 or clinically indicated)*	
	B. EARS - GENERAL *(INTERNAL CANALS)* *(Auditory acuity under items 39 and 40)*			P. TESTICULAR	
				Q. ANUS AND RECTUM *(Hemorrhoids, Fistulae)* *(Hemoccult Results)*	
	C. DRUMS *(Perforation)*			R. ENDOCRINE SYSTEM	
	D. NOSE			S. G-U SYSTEM	
	E. SINUSES			T. UPPER EXTREMITIES *(Strength, range of motion)*	
	F. MOUTH AND THROAT			U. FEET	
	G. EYES - GENERAL *(Visual acuity and refraction under items 28, 29, and 36)*			V. LOWER EXTREMITIES *(Except feet)* *(Strength, range of motion)*	
	H. OPTHALMOSCOPIC			W. SPINE, OTHER MUSCULOSKELETAL	
	I. PUPILS *(Equality and reaction)*			X. IDENTIFYING BODY MARKS, SCARS, TATTOOS	
	J. OCULAR MOTILITY *(Associated parallel movements nystagmus)*			Y. SKIN, LYMPHATICS	
	K. LUNGS AND CHEST			Z. NEUROLOGIC *(Equilibrium tests under item 41)*	
	L. HEART *(Thrust, size, rhythm, sounds)*			AA. PSYCHIATRIC *(Specify any personality deviation)*	
	M. VASCULAR SYSTEM *(Varicosities, etc.)*			BB. BREASTS	
	N. ABDOMEN AND VISCERA *(Include hernia)*			CC. PELVIC *(Females only)*	

NOTES: *(Describe every abnormality in detail. Enter pertinent item number before each comment. Continue in item 42 and use additional sheets if necessary.)*

18. DENTAL *(Place appropriate symbols, shown in examples, above or below number of upper and lower teeth.)*

Examples: 0 over 1 2 3 / 32 31 30 / 0 = Restorable Teeth; / over 1 2 3 / 32 31 30 / / = Non-restorable Teeth; X over 1 2 3 / 32 31 30 / X = Missing Teeth; X X X over 1 2 3 / 32 31 30 / X X X = Replaced by Dentures; (X) over 1 2 3 / 32 31 30 / (X) = Fixed Partial Dentures

RIGHT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	LEFT
	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	

REMARKS AND ADDITIONAL DENTAL DEFECTS AND DISEASES

19. TEST RESULTS (Copies of results are preferred as attachments)

A. URINALYSIS: (1) SPECIFIC GRAVITY		B. CHEST X-RAY OR PPD *(Place, date, film number and result)*
(2) URINE ALBUMIN	(4) MICROSCOPIC	
(3) URINE SUGAR		
C. SYPHILIS SEROLOGY *(Specify test used and results)*	D. EKG / E. BLOOD TYPE AND RH FACTOR	F. OTHER TESTS

NSN 7540-00-634-4036
88-126
Designed using Perform Pro, WHS/DIOR, Jan 97

STANDARD FORM 88 (Rev. 10-94) (EG)
Prescribed by GSA/ICMR FIRMR (41 CFR) 201-9.202-1

NAME	IDENTIFICATION NUMBER	NO. OF SHEETS ATTACHED

MEASUREMENTS AND OTHER FINDINGS

20. HEIGHT	21. WEIGHT	22. COLOR HAIR	23. COLOR EYES	24. BUILD ☐ SLENDER ☐ MEDIUM ☐ HEAVY ☐ OBESE	25. TEMPERATURE

26. BLOOD PRESSURE *(Arm at heart level)*						27. PULSE *(Arm at heart level)*				
A. SITTING	SYS. / DIAS.	B. RECUMBENT	SYS. / DIAS.	C. STANDING *(5 mins.)*	SYS. / DIAS.	A. SITTING	B. RECUMBENT	C. STANDING *(3 mins)*	D. AFTER EXERCISE	E. 2 MINS. AFTER

28. DISTANT VISION		29. REFRACTION			30. NEAR VISION	
RIGNT 20/	CORR. TO 20/	BY	S.	CX	CORR. TO	BY
LEFT 20/	CORR. TO 20/	BY	S.	CX	CORR. TO	BY

31. HETEROPHORIA *(Specify distance)*

ESO	EXO	R.H.	L.H.	PRISM DIV.	PRISM CONV. CT	PC	PD

32. ACCOMMODATION		33. COLOR VISION *(Test used and result)*	34. DEPTH PERCEPTION *(Test used and score)*	UNCORRECTED
RIGHT	LEFT			CORRECTED
35. FIELD OF VISION		36. NIGHT VISION *(Test used and score)*	37. RED LENS TEST	38. INTRAOCULAR TENSION
RIGHT	LEFT			RIGHT / LEFT

39. HEARING			40. AUDIOMETER								41. PSYCHOLOGICAL AND PSYCHOMOTOR *(Tests used and score)*
RIGHT W/V	/15SV	/15		250 256	500 512	1000 1024	2000 2048	3000 2896	4000 4096	6000 6144	8000 8192	
LEFT W/V	/15SV	/15	RIGHT									
			LEFT									

42. NOTES *(Continued)* AND SIGNIFICANT OR INTERVAL HISTORY

(Use additional sheets if necessary)

43. SUMMARY OF DEFECTS AND DIAGNOSES *(List diagnoses with item numbers)*

44. RECOMMENDATIONS - FURTHER SPECIALIST EXAMINATIONS INDICATED *(Specify)*	45A. PHYSICAL PROFILE					
	P	U	L	H	E	S
46. EXAMINEE *(Check)* A. ☐ IS QUALIFIED FOR B. ☐ IS NOT QUALIFIED FOR	45B. PHYSICAL CATEGORY					
47. IF NOT QUALIFIED, LIST DISQUALIFYING DEFECTS BY ITEM NUMBER	A		B		C	E

48. TYPED OR PRINTED NAME OF PHYSICIAN	SIGNATURE
49. TYPED OR PRINTED NAME OF PHYSICIAN	SIGNATURE
50. TYPED OR PRINTED NAME OF DENTIST OR PHYSICIAN *(Indicate which)*	SIGNATURE
51. TYPED OR PRINTED NAME OF REVIEWING OFFICER OR APPROVING AUTHORITY	SIGNATURE

STANDARD FORM 88 (Rev. 10-94) **BACK**

APPENDIX F.
MEDICAL RECORDS DATABASE DESIGN AND CODING

INJURY DATA – Enter the following for each medical visit for injury:

Date of Visit: (DD-MMM-YY, e.g. 12-JAN-09).

Follow-up?: "No" indicates a first visit for this condition; "yes" indicates a follow-up visit (subject was seen previously for this condition). Default value is "no" (0).
0=no
1=yes
8=unknown

Associated Training Activity: Training activity associated with the injury (if any). Sometimes the training activity is not listed for the initial visit but is listed for a follow-up visit. Default value is "not applicable" (97).

Physical training (PT)	Case Scenario (Hogan's Alley)
Sports	Off-Duty, Academy
Defensive Tactics Training	Off-Duty, Not Academy
Operational Skills Training	other
Firearms Training	not applicable
Driver Training	unknown
Physical Fitness Testing	

Activity/Mechanism Notes: Enter a more detailed description of how the injury occurred. Record exactly what is in the medical record.

Diagnosis: Choose one of the following diagnoses from the drop box. Default value is 0–"no visits."

	Code	Abbreviation	Description
Overuse Injuries	1	STR_FX	stress fracture
	2	STR_RXN	stress reaction
	3	TND	tendonitis
	4	DJD	degenerative joint disease
	5	BURS	bursitis
	6	FASC	fasciitis
	7	RPPS	retropatellar pain syndrome
	8	IMP	impingement
	9	STRAIN_OU	muscle injury, not involving joint, due to overuse
	10	SPRAIN_OU	joint injury due to overuse
	11	PAIN_OU	musculoskeletal pain due to overuse
	12	OTH_OU	overuse injury, other
	13	SHIN_SPL	shin splints
Traumatic Injuries	14	STRAIN_TR	muscle injury, not involving joint, due to a traumatic event
	15	SPRAIN_TR	joint injury due to a traumatic event
	16	PAIN_TR	musculoskeletal pain due to traumatic event

	17	OTH_TI	other traumatic injury
	18	DISLOCN	dislocation
	19	DERANG	joint derangement (e.g. meniscus tear)
	20	FRACT	Fracture
	21	BLISTER	Blister
	22	ABRSN_LC	abrasion or laceration
	23	CONTSN	contusion
	24	CONCUSS	Concussion
	26	OPENWND	open wound
Other Injuries	26	OTH_MS	other musculoskeletal injury, not listed above
	27	NEURO	neurological
Environmental Injuries	28	HEAT	heat-related injury or illness (e.g., heat exhaustion, dehydration)
	29	COLD	cold-related injury or illness (e.g., frostbite, hypothermia)
	30	BITE_IN	insect bites or stings
	31	BITE_AN	other animal or snake bite
	32	RHABDO	Rhabdomyolysis
	33	OTH_ENV	other, environmental/toxic injury
Miscellaneous Categories	0	NO_VISITS	no visits
	96	OTH_INJ	other injury
	97	NORMAL	normal exam – nothing found
	98	UNK	Unknown

Diagnosis Notes: Enter a more detailed description of the diagnosis. Record exactly what is in the medical record.

Body Side: This is typically given with the subjective or assessment portion of the SOAP.

Left
Right
Bilateral
Midline
Other
Unknown

Body part: This is typically given with the diagnosis.

Code	Abbreviation	Description	Code	Abbreviation	Description
1	HEAD	head	16	FINGER	finger
2	FACE	face	17	PELV_REG	pelvic region
3	EAR	ear	18	HIP	hip
4	EYE	eye	19	POST_THIGH	posterior thigh (hamstring)
5	NECK	neck	20	ANT_THIGH	anterior thigh (quadriceps)
6	CHEST	chest	21	KNEE	knee
7	ABDMN	abdomen	22	CALF	calf

8	UP_BACK	upper back	23	SHIN	shin
9	LO_BACK	lower back	24	ANKLE	ankle
10	SHLDR	shoulder	25	FOOT	foot
11	ELBOW	elbow	26	TOE	toe
12	UP_ARM	upper arm	27	MULTI	multiple
13	LO_ARM	lower arm	96	OTH	other
14	WRIST	wrist	97	NA	not applicable
15	HAND	hand	98	UNK	unknown

Disposition: Final outcome of the injury visit as assigned by the medical provider. If the provider issued both a consult and limited duty, list limited duty.

Returned to duty
Limited duty (and RTD)
Quarters
Hospitalized
Consult
Other
Not applicable
Unknown

Days of Limited Duty: Enter the number of days of limited duty given to the NAT. Enter 0 if the no days of limited duty are given (Disposition=Returned to duty). Days of limited duty are typically found with the disposition. If limited duty is indicated, but no days are listed, enter 99 (missing).

Additional Notes: Enter miscellaneous notes on events surrounding the occurrence of the injury or illness.

Appendix G. CA-1 Form. Federal Employee Notice of Traumatic Injury and Claim for Continuation of Pay Compensation

Federal Employee's Notice of Traumatic Injury and Claim for Continuation of Pay/Compensation

Reset Print

U.S. Department of Labor
Office of Workers' Compensation Programs

Employee: Please complete all boxes 1 - 15 below. Do not complete shaded areas.
Witness: Complete bottom section 16.
Employing Agency (Supervisor or Compensation Specialist): Complete shaded boxes a, b, and c.

Employee Data

1. Name of employee (Last, First, Middle)
2. Social Security Number
3. Date of birth Mo. Day Yr.
4. Sex ☐ Male ☐ Female
5. Home telephone
6. Grade as of date of injury Level ☐ Step ☐
7. Employee's home mailing address (Include city, state, and ZIP code)
8. Dependents
   - ☐ Wife, Husband
   - ☐ Children under 18 years
   - ☐ Other

Description of Injury

9. Place where injury occurred (e.g. 2nd floor, Main Post Office Bldg., 12th & Pine)
10. Date injury occurred Mo. Day Yr. / Time ☐ a.m. ☐ p.m.
11. Date of this notice Mo. Day Yr.
12. Employee's occupation
13. Cause of injury (Describe what happened and why)
14. Nature of injury (Identify both the injury and the part of body, e.g., fracture of left leg)
    - a. Occupation code
    - b. Type code
    - c. Source code
    - OWCP Use - NOI Code

Employee Signature

15. I certify, under penalty of law, that the injury described above was sustained in performance of duty as an employee of the United States Government and that it was not caused by my willful misconduct, intent to injure myself or another person, nor by my intoxication. I hereby claim medical treatment, if needed, and the following, as checked below, while disabled for work:

☐ a. Continuation of regular pay (COP) not to exceed 45 days and compensation for wage loss if disability for work continues beyond 45 days. If my claim is denied, I understand that the continuation of my regular pay shall be charged to sick or annual leave, or be deemed an overpayment within the meaning of 5 USC 5584.

☐ b. Sick and/or Annual Leave

I hereby authorize any physician or hospital (or any other person, institution, corporation, or government agency) to furnish any desired information to the U.S. Department of Labor, Office of Workers' Compensation Programs (or to its official representative). This authorization also permits any official representative of the Office to examine and to copy any records concerning me.

Signature of employee or person acting on his/her behalf _____ **Date** _____

Any person who knowingly makes any false statement, misrepresentation, concealment of fact or any other act of fraud to obtain compensation as provided by the FECA or who knowingly accepts compensation to which that person is not entitled is subject to civil or administrative remedies as well as felony criminal prosecution and may, under appropriate criminal provisions, be punished by a fine or imprisonment or both.

Have your supervisor complete the receipt attached to this form and return it to you for your records.

Witness Statement

16. Statement of witness (Describe what you saw, heard, or know about this injury)

Name of witness | Signature of witness | Date signed

Address | City | State | ZIP Code

Form CA-1
Rev. Apr. 1999

Epidemiological Report No. 12-HF-97HRF1A-10, MARCH 2009-MARCH 2010

Official Supervisor's Report: Please complete information requested below:

Supervisor's Report

17. Agency name and address of reporting office (include city, state, and zip code)

OWCP Agency Code

OSHA Site Code

ZIP Code

18. Employee's duty station (Street address and ZIP code)

19. Employee's retirement coverage ☐ CSRS ☐ FERS ☐ Other, (identify)

20. Regular work hours From: ☐ a.m. ☐ p.m. To: ☐ a.m. ☐ p.m.

21. Regular work schedule ☐ Sun. ☐ Mon. ☐ Tues. ☐ Wed. ☐ Thurs. ☐ Fri. ☐ Sat.

22. Date of Injury Mo. Day Yr.

23. Date notice received Mo. Day Yr.

24. Date stopped work Mo. Day Yr. Time: ☐ a.m. ☐ p.m.

25. Date pay stopped Mo. Day Yr.

26. Date 45 day period began Mo. Day Yr.

27. Date returned to work Mo. Day Yr. Time: ☐ a.m. ☐ p.m.

28. Was employee injured in performance of duty? ☐ Yes ☐ No (If "No," explain)

29. Was injury caused by employee's willful misconduct, intoxication, or intent to injure self or another? ☐ Yes (If "Yes," explain) ☐ No

30. Was injury caused by third party? ☐ Yes ☐ No (If "No," go to item 32.)

31. Name and address of third party (Include city, state, and ZIP code)

32. Name and address of physician first providing medical care (Include city, state, ZIP code)

33. First date medical care received Mo. Day Yr.

34. Do medical reports show employee is disabled for work? ☐ Yes ☐ No

35. Does your knowledge of the facts about this injury agree with statements of the employee and/or witnesses? ☐ Yes ☐ No (If "No," explain)

36. If the employing agency controverts continuation of pay, state the reason in detail.

37. Pay rate when employee stopped work $ Per

Signature of Supervisor and Filing Instructions

38. A supervisor who knowingly certifies to any false statement, misrepresentation, concealment of fact, etc., in respect of this claim may also be subject to appropriate felony criminal prosecution.

I certify that the information given above and that furnished by the employee on the reverse of this form is true to the best of my knowledge with the following exception:

Name of supervisor (Type or print)

Signature of supervisor

Date

Supervisor's Title

Office phone

39. Filing instructions
- ☐ No lost time and no medical expense: Place this form in employee's medical folder (SF-66-D)
- ☐ No lost time, medical expense incurred or expected: forward this form to OWCP
- ☐ Lost time covered by leave, LWOP, or COP: forward this form to OWCP
- ☐ First Aid Injury

Form CA-1
Rev. Apr. 1999